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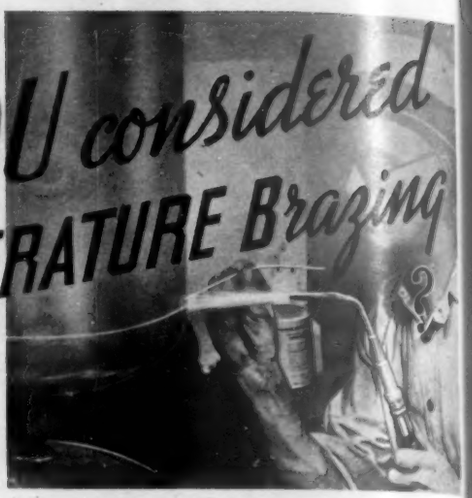

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BUILDING BETTER PRODUCTS

AT THIS season of the year it is well to reflect a bit on the progress made in welding during the past year. October and November are the big convention months in the metal working industries. Welding engineers and metallurgists assemble together for group meetings to discuss their common problems and pass on the benefit of specialized knowledge gained in their particular fields. It is a characteristic of our modern age that through technical and professional associations, we secure a wide dissemination of fundamental knowledge and in this way make it possible for everybody to progress. In an earlier day, secrecy of processes was deemed the best way to get ahead of your competitor. Today, a new spirit prevails in industry.

Recent figures compiled by the American Iron and Steel Institute show that more than 140 million pounds of steel welding rod and electrodes were produced in 1936. This is estimated to be enough wire to make a strong weld 134,000 miles long. The 1936 production was an increase of about 480 per cent over the depression year 1932. During the same interval of time, steel ingot production increased 250 per cent. Obviously, consumption of welding wire increased faster than ingot production. Charts prepared by *The Welding Engineer* for exhibition at the National Metal Exposition showed that steel welding wire production per ton of ingot was stepped up from 1.79 pounds per ton in 1932 to 2.95 pounds in 1936.

The remarkably rapid increase in welding within recent years has created a new and growing market for the products of the steel industry. Many structures are now produced by welding together steel sheets, plates, bars and other rolled products, where formerly they were made by other methods. Welding is now used extensively in the construction of ships, pipelines, pressure vessels, storage tanks, heavy machinery, building structures, airplane fuselages, diesel engines, material handling equipment, and a host of other mechanical devices.

A. E. Gibson, past president of the American Welding Society, very aptly pointed out the reason for the general acceptance of welding as a major method of fabrication: "We are building better products by welding and generally building them at a lower cost. . . . Development and widespread use of the new low-alloy, high-strength steels," remarked Mr. Gibson recently, "have made possible designs of extremely low weight and high strength." The railroad equipment builders have been quick to utilize these new materials to obtain long life, low upkeep, and reduced operating cost.

Recent improvements in coated rods and electrodes and in welding procedure have contributed greatly to the increased acceptance of welding. Today we have weld metal of higher strength, reaching as high as 100,000 pounds. Looking back ten years, weld metal with a tensile strength of 50,000 pounds was above average. With increase in tensile strength, we have improved ductility and other physical properties, with the result that welds can now be made equal in every respect to the strength of the base metal, in some cases actually stronger.

As the value and design advantages of welding gain more widespread recognition in numerous industrial fields, better product designs at lower cost will enable those companies who are alert enough to take hold of it to expand their own markets and give better service at a substantial cost saving. Truly, welding has a bright future.

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Welded Gears and Their Place in Heavy Machinery

Experience of last few years proves definitely that welded gears will stand up under severe working conditions

By E. C. BRECKELBAUM
Welding Foreman, Harnischfeger Corp., Milwaukee, Wis.

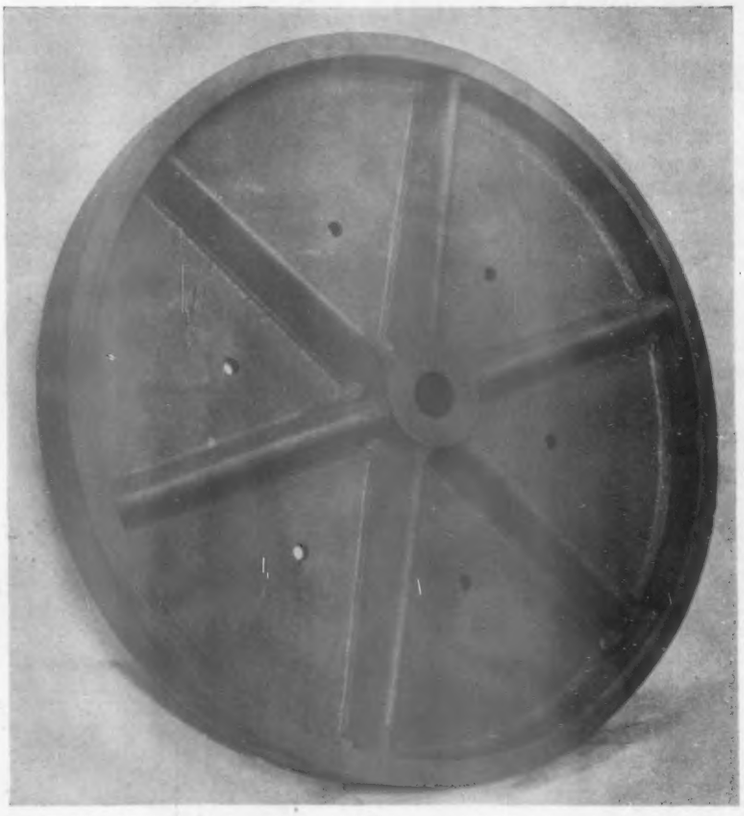

Fig. 1—Single disc web helical gear with hollow box-type ribs

IN the last few years the use of the welded gear in heavy machinery has changed from an emergency repair application to a production made product, which has found a definite and lasting place in the industry. One might wonder how it is possible that welded gears have made such rapid progress in the last few years.

The welding of gears has definite advantages over the other methods of production (casting or forging), in design, manufacture, and economy. In a welded gear, it is possible to do things with the material which are not possible in either a cast or forged gear. In a welded gear, one can place the kind and amount of metal just as needed. That is, for the rim material (tooth material) one can use a high carbon (S.A.E. 1040) or a low alloy steel (MANTEN), which can be hardened through suitable heat-treatment. This gives a satisfactory wearing surface for the gear teeth.

For the web disc or spokes the ordinary steel plate (S.A.E. 1020) gives a tough and ductile material. For the hub material, the machine steel (S.A.E. 1035) is hard enough for the single or multiple spline, and not too hard to give difficulty in machining. In a cast or forged gear, one either has to use an expensive alloy steel, or the ordinary cast steel or iron all the way through. This either means using the expensive material throughout, or using the ordinary steel or iron which does not give a satisfactory tooth surface from standpoint of hardness and wearing quality.

Several years of manufacturing experience in welded gears show a saving from 30 to 50 per cent over cast or forged gears. In this comparison, die or pattern costs are not figured. There is another big advantage of welded gears; they can be changed to suit each individual requirement without any high pattern or die cost being involved. This has been found especially advantageous in the crane building industry because of the amount of variation needed to meet the customer's needs. We found that the savings in manufacturing costs and

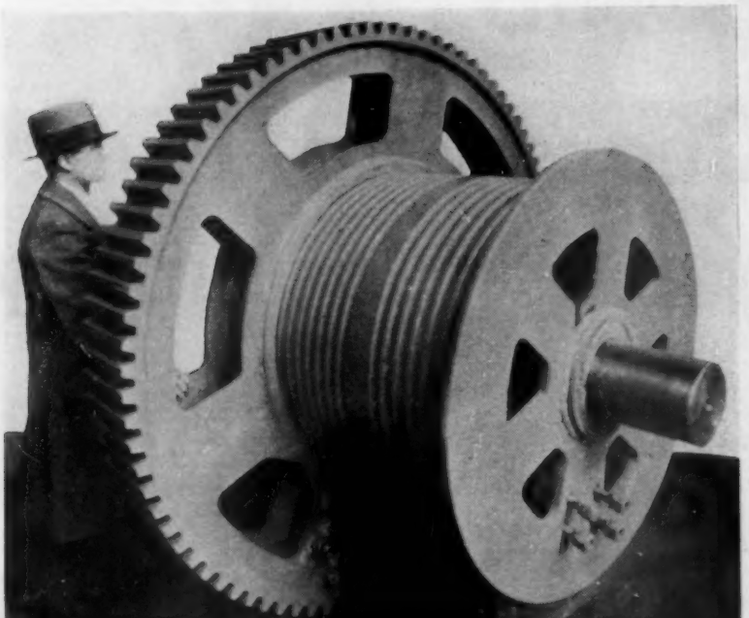

Fig. 2—Wide-faced welded spur gear pressed on a welded cable drum—Note double web type of construction

patterns for single large gears often run into several hundred dollars per gear.

As far as quality and life of the welded gears are concerned, the last few years have proved that the welded gears do stand up under the most severe working conditions and that they can be safely and efficiently produced on a regular production basis. In the last few years we have made several thousand different welded gears of many different designs, and we have had very few failures. These failures were due to minor deficiencies in design or production control which were easily eliminated.

In gear design, the gears can be classified into two distinct groups. There is the spur and herringbone gear class where the transmitted force does not exert any side thrust from the tooth pressures; and there is the helical and worm gear group where the transmitted force exerts a side thrust due to the angular tooth pressure which may be of tremendous magnitude. Gears without side thrust of any magnitude are best made in welded construction with a solid disc web, with a few punched holes for clamping in machining and to take out the drum effect. Welded gears with large side thrusts are best made either with a single web and hollow box type of rib construction, or with a double web construction. For this group of gears the dished web or conical web gear also has great advantages, but this type of gear, as yet, has not found large application in the industry today.

The accompanying illustrations show the different applications of the welded gears. Figure 1 shows a single disc web helical gear with hollow box type ribs. The ribs have a cross section of an inverted 60-deg. angle. Inverted U or channel type box sections can also be used for gear ribs. Figure 2 shows a wide-faced welded spur gear pressed onto a welded cable drum. This is the

Fig. 3—Large herringbone gear before machining—Note angular joining of ends of rim, a common practice with large gears

"With heavy gears which are likely to give high tied-up stresses, the deep seam weld is left until the last, allowing an opening for some of the tied-up stresses to get away. The gears are welded on suitable positioning tables to get perfect, even penetration and perfect 45 deg. fillets. The positioning tables allow at the same time a fast production of the circular seams and ribs. The circular seams are welded in two passes. The first pass is made with an all-position rod which is comparatively slow, but has good penetration and does not produce heat stresses of too great a magnitude. This first pass is best made with a 3/16 in. electrode. The second pass is made with a fast downhand electrode of ¼ in. or 5/16 in. size."

—E. C. Breckelbaum

main cable drum of a 4 cu. yd. excavator. The gear illustrates a double web type of construction. Figure 3 shows a large herringbone gear before machining. The picture clearly shows the angular joining of the ends of the rim which is advantageously done with large gears. Figure 4 shows the welding of a large roller track and swing gear unit of an excavator on one of the large positioners. Figure 5 shows a welded swing gear on one of the smaller power-driven positioners.

Figure 6 shows the combination of a casting and plate to form a clutch swing gear. The jaw clutch and gear hub are a cast steel unit welded into the steel plate disc and rolled bar stock rim. Figure 7 shows the machined internal ring of a small hoist. This small gear weighing only 9 lbs. (in the rough) used to be made as an alloy steel casting. They were made in lots of 100, and always more than half of them had to be rejected because of blow holes and imperfections. Of 150 welded gears only two have been rejected, thus saving a tremendous amount of wasted labor and time.

There are two main problems of general interest in the manufacture of welded gears. The deep seam weld joining the gap in the ring, rolled and formed from bar stock, is one of the problems that needs attention. There are several ways of designing and making this seam, but we shall only discuss one of the most important. This method is shown in Figure 1. In this method the rim is welded from the inside, which makes it necessary to weld the rim complete before the as-

Fig. 4—Welding of huge roller track and swing gear unit of a big excavator—Work is mounted on a large positioner

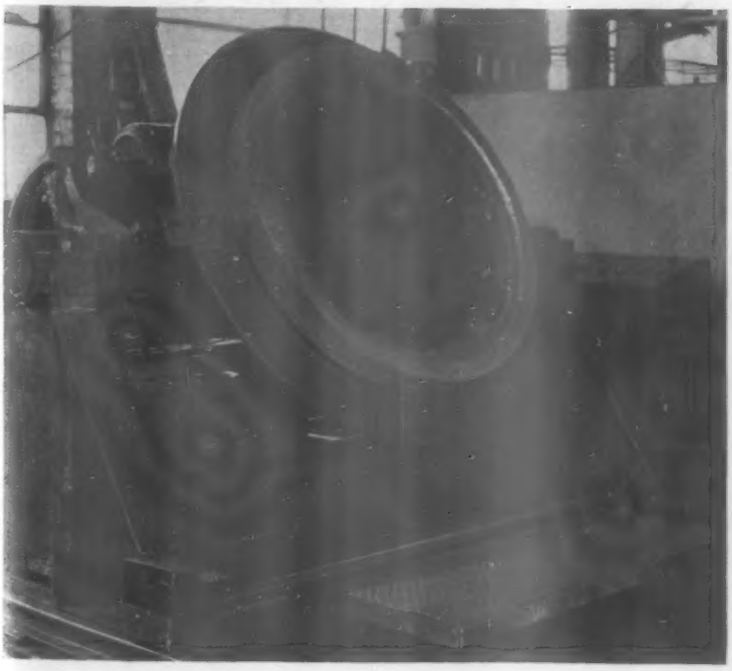

Fig. 5—A small sized welding swing gear mounted on a completely power-driven positioner

"Several years of manufacturing experience in welded gears show a saving of from 30 to 50 per cent over cast or forged gears. In this comparison, die or pattern costs are not figured. There is another big advantage of welded gears; they can be changed to suit each individual requirement without any high pattern or die cost being involved. This has been found especially advantageous in the crane building industry because of the amount of variation needed to meet the customer's needs. We found that the savings in manufacturing costs and patterns for single large gears often run into several hundred dollars per gear.

"As far as quality and life of the welded gears are concerned, the last few years have proved that the welded gears do stand up under the most severe working conditions and that they can be safely and efficiently produced on a regular production basis. In the last few years we have made several thousand welded gears of many different designs, and we have had very few failures. These failures were due to minor deficiencies in design or production control which are easily eliminated."

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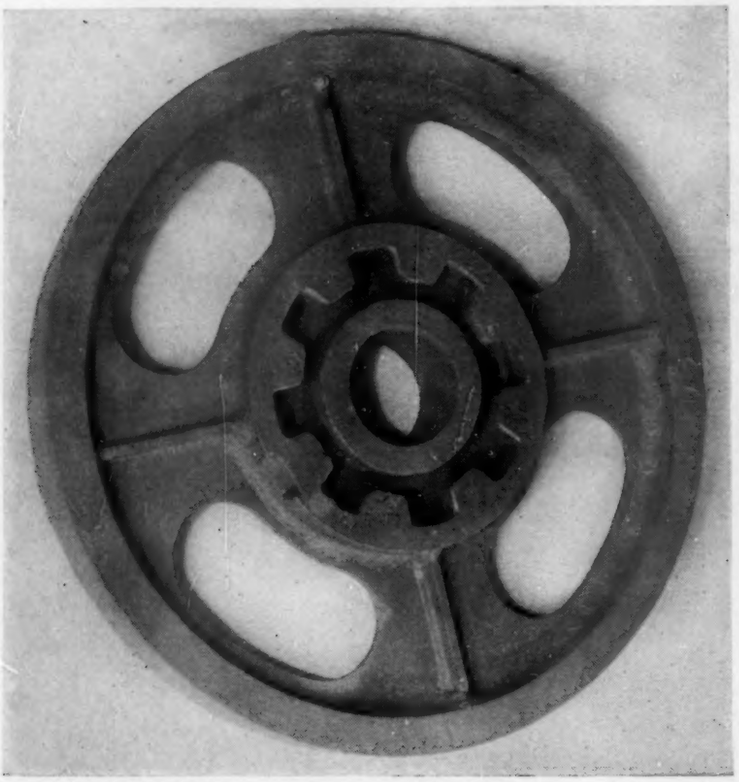


Fig. 6—Combination of casting and plate to form a clutch swing gear—Jaw clutch and gear hub are a cast steel unit welded into the steel plate disc

sembly of the gear. With this type of weld the advantage is that the apex of the V-weld falls at the gap of the tooth, and so if the rim ends come close together no back bead is necessary. Most of the weld falls in the gap of the tooth, and thus the tooth at the weld is mostly of parent metal.

The difficulty with this method of production is that it is practically impossible to assemble this gear economically after the rim is welded into a complete ring. This is due to the variation in the flame cut web plate and the not-perfectly-round rim. To get any sort of economical production with this method, the rim ring would have to be rough bored and the web plate rough turned to aid in the assembly.

Another problem in the production welding of gears is the welding of the circular seam and ribbing. Because of the circular shape of the gears, the heat stresses that are built up during welding cannot get away, and unless due precaution is taken, the tied up stresses will become too high and cracked welds will be the result. We all know that by preheating the gears, or by using intricate "step-back" methods that the cracking can be prevented, but in production it was found most satisfactory to use the following method, which has given very good and consistent results.

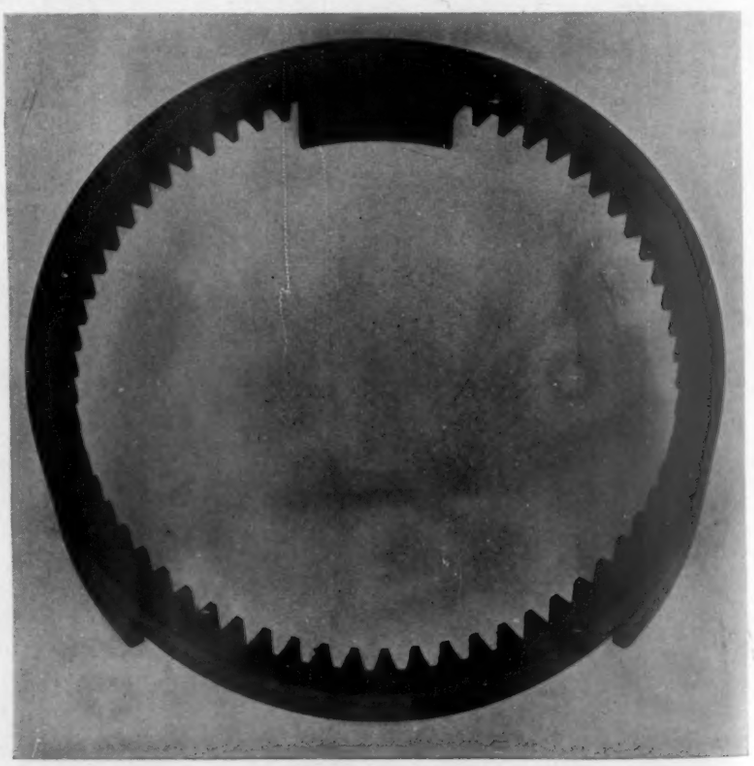
With heavy gears which are likely to give high tied-up stresses, the deep seam weld is left until the last, allowing an opening for some of the tied up stresses to get away. The gears are welded on suitable positioning tables to get perfect, even penetration and perfect 45 deg. fillets. The positioning tables allow at the same time a fast production of the circular seams and ribs. The circular seams are welded in two passes. The first pass is made with an all-position rod which is comparatively slow, but has good penetration and does not produce heat stresses of too great a magnitude. This first pass is best made with a 3/16 in. electrode. The second pass is made with a fast down-hand electrode of 1/4 in. or 5/16 in. size.

Using this procedure no difficulties with cracking of welds are experienced. The gears are all stress-relieved and heat-treated for their specific Brinell requirements. The gears which are to be machined after heat-treatment are hardened to 300—350 Brinell.

The latest method of making welded gears, that can compete with tool steel gears in all respects is: (1) stress-relieving the welded gear made with a low alloy steel rim; (2) then machining the gear completely to finished dimensions; (3) and then flame-hardening the teeth to around 450 Brinell. Flame-hardening is especially effective with welded gears and is going to give welded gears an even greater future.*

*Refer to article "Flame Hardening of Machine Parts" by L. A. Lindberg, page 37, September, 1937 issue of The Welding Engineer.

Fig. 7—Machined internal ring gear of small hoist — Formerly made as an alloy steel casting, but too many had to be rejected because of blow holes and other imperfections



Welding and Cutting Fires

It is estimated that 80 to 90 per cent of all "welding fires" arise from flame cutting operations with portable equipment

By J. I. BANASH and H. F. REINHARD*

Consulting Engineer and Secretary respectively, of the International Acetylene Association, New York

PRACTICALLY since the inception of the oxy-acetylene industry, the manufacturers of gases and equipment for welding and cutting have been conscious of the necessity for accident prevention. Over the course of a good many years, through cooperation with regulatory bodies and users, and through the interchange of information in the industry, it has been possible to safeguard oxy-acetylene equipment to an exceptional degree. Welding gases, their shipping containers, and welding equipment have been safeguarded as far as possible at their source. In every new design safety is considered paramount, and even though the tremendous increase in the amount of apparatus in use multiplies any potential accident hazards, the record from the accident prevention point of view is well known to be excellent.

In the last ten years, the number of oxy-acetylene blow-pipes or torches in use has increased more than tenfold, and today in this country there are probably in excess of one-half million in use. Besides this, each piece of equipment is used much more frequently than formerly on account of the growing appreciation of the torch as a universal tool of industry. This is reflected in the still greater increase in the use of welding gases. Even so, these figures are offered, not as an excuse for increasing numbers of fires, but rather to indicate how the oxy-acetylene process has permeated our industrial structure until an observer now feels that the absence of some such equipment in any modern plant is really conspicuous. Therefore, the problem of fire prevention is one of major importance, and although fairly simple, it must be remembered that the equipment which actually causes the fire has passed out of the control of the oxy-acetylene industry and to the user.

Portable cutting operations during repair, alteration, or demolition work, sometimes cause fires

The oxy-acetylene industry however feels a responsibility—moral perhaps—but none the less definite. It desires to use every means available in assisting the user to educate his employees not only in safe practices which will prevent injuries, but in the related and important subject of fire prevention. That fires

*Paper presented at 26th National Safety Congress and Exposition, Kansas City, Mo., October 12.

"Studies prove that fires occur largely in portable cutting operations, that is, cutting done during repair, alteration or demolition work or in some intermittent use, and usually when the operation is not under the direct control of the foreman of the department where the work is being done. To stress the point again, we estimate that about 90 per cent of all fires that occur during welding and cutting, occur while using portable equipment, and we further estimate that from 80 to 90 per cent of these fires occur during flame cutting, rather than welding. In these portable cutting operations, our studies make it obvious that some lack of knowledge, supervision or interest on the part of the operator has been largely responsible for the fires." —J. I. Banash and H. F. Reinhard

are in a large measure unnecessary has been proven and fires involving the use of oxy-acetylene equipment can be prevented by the use of reasonable safeguards and without unduly slowing up the work or interfering with in in any other way. For these reasons we present the following with the thought that the oxy-acetylene industry will cooperate to the fullest extent with the users of its products in a continuous fire prevention campaign.

The purpose of this paper is to set forth from the viewpoint of the oxy-acetylene industry, a few simple, inexpensive precautions—the the adoption of which is strongly urged. We wish every user of the torch or blowpipe to be entirely conversant with the simple procedure so necessary to conserve property. Only if such precautions are followed and the number of fires thereby decreased, will the continued wide use of the welding and cutting torch continue unhampered.

When a welding or cutting operation to be carried out is a part of a production process, when it is stationary, when arrangements can be made for safeguarding surroundings and the material on which the work is being done, and when repeated operations of the same nature are carried out in one place, it is rare indeed that a fire occurs. Admitting, however, that there are too many fires, where do they originate?

Studies prove that fires occur largely in portable cutting operations, that is, cutting done during repair, alteration or demolition work or in some intermittant use, and usually when the operation is not under the direct control of the foreman of the department where the work is being done. To stress the point again, we estimate that about 90 per cent of all fires that occur during welding and cutting, occur while using portable equipment, and we further estimate that from 80 to 90 per cent of these fires occur during flame cutting, rather than welding. In these portable cutting operations, our studies make it obvious that some lack of knowledge, supervision or interest on the part of the operator has been largely responsible for the fires.

Extreme Caution Needed

It should be entirely clear to everyone that the oxy-acetylene flame has no place in any location where a flame or open light of any kind would not be permitted. This sounds academic, but it is surprising how many times an oxy-acetylene flame, with its very high temperature, is employed in places where a match or a spark or a forge or a gasoline torch would not be allowed. In nearly every plant or shop there are such places. For instance, extreme care is always necessary near combustible gases or flammable liquids, and such things as blow-torches, open lights, sparking tools and other possible sources of ignition must be prohibited. But welding and cutting can be done in most other locations with safety if certain reasonable precautions are taken. Knowing the way that fires may start is an important step in learning how to prevent them.

Heat sufficient to start fires may come from the oxy-acetylene flame itself; from metals being welded or cut; from the *molten slag or metal that falls or drops from the cut;* or from sparks that fly from the work. Some materials will, of course, catch fire from these sources of heat more quickly than others. Flammable gases and liquids with air or oxygen present are examples of materials that will flare up at once. Oily wastes and rags and materials such as burlap, excelsior, straw and paper catch fire less easily, but burn vigorously when once started. Wooden flooring, timber structures, scrap lumber, wood chips, tarpaulins and similar material are less apt to catch fire than the others mentioned, but precautions must be taken with any such combustible materials. Fires started in them may only smolder at first and then flare up sometime later due possibly to a gust of air or a natural draft created by the heat from the smoldering material.

The oxy-acetylene flame is itself rarely the cause of a fire; probably because it is subconsciously evident to anyone using it that the extremely high temperature flame and flammable or combusible materials should be kept apart. Heat from the metal being welded or cut may sometimes be the cause of fires if hot pieces of metal are allowed to touch materials that burn readily. This may happen in the case of cutting steel and iron when small pieces are cut away from larger pieces and allowed to drop onto the floor or ground. The smaller or narrower the piece cut away, the higher its temperature is likely to be, and the more likely, therefore, to set fire to burnable materials. Pieces of iron or steel which have been heated to a bright red heat may remain above the kindling temperature from 5 to 15 sec. or even much longer under some conditions. Even though the piece may appear to be at a black heat in daylight, it can scorch such things as wood or paper, and a fire may start if there is enough draft.

Fires that do occur during the use of the oxy-acetylene torch are largely caused by globules of hot metal and slag from cutting operations. Because of this, for immediate results, it seems that most of our efforts should be directed toward the cause of most of the trouble—the use of portable oxy-acetylene cutting equipment. It does no good to debate the question of whether a fire has been caused by a spark or a drop of molten metal or hot slag. The practical fact remains that hot globules of metal, hot slag and sparks are all formed in flame cutting operations, and all of them are capable of igniting flammable liquids, gas-air mixtures or combustible materials.

Watch Flying Sparks

Because sparks from cutting or welding, particularly from cutting, may fly in so many directions at once, and because they sometimes travel for a considerable distance, they must be watched closely to make sure that they do not start fires. Sparks are really little glowing particles of metal oxides, and some of the larger ones may retain enough heat to start fires for several seconds after landing. The heavy sparks from cutting work sometimes travel 25 ft. away from the point of cutting and can readily set fire to light materials such as excelsior, paper, or oily rags. It goes without saying that if sparks should fall into containers holding flammable liquids or spaces containing mixtures of flammable vapors and air, quick and dangerous fires will result.

It is also very important to realize that sparks which fly some distance or which roll along a floor may cause smoldering fires. Smoldering fires may start by sparks getting in the cracks or floors and woodwork or by sparks flying on materials such as rags, tarpaulins, paper wrappings, wood chips, scrap lumber, and cushion padding. Sometimes these fires go out of their own accord and sometimes they continue to smolder and finally burst into flame as long as one-half hour later. Sparks may also drop through cracks in floors or between floors and columns and ignite combustible material on the floor below. Special attention should be given to such sparks when using the cutting torch in the construction, repair or demolition of buildings.

Oxy-acetylene equipment should be handled safely and sensibly —A small fire is a potential big fire

Fire Prevention Rules

Certain definite rules for the prevention of fires when welding and cutting have been formulated. Although we are dealing herein with gas welding and cutting only, the same rules with one exception, apply to any hot operation. These suggested safe practices are as follows:

1. Do not perform "hot" work where any open flame would be dangerous, as in or near rooms containing flammable vapors or liquids, or exposed loose combusible stock.

2. Be sure that cutting and welding equipment is not used near dipping or spraying rooms, or rooms containing loose, readily combustible material, unless there is no possibility of the vapors or of sparks and molten metal passing through broken or open windows, open doorways, or cracks or holes in walls or floors, or otherwise reaching combustible vapors which are often heavier than air.

3. If the work can be moved, it is better to take it to a safe place for cutting and welding than to perform the work in a hazardous location. A non-combustible room or building, or one provided with an automatic sprinkler system is usually considered a safe location.

Combustible Material

4. Where welding or cutting has to be done in the vicinity of combustible material, special precautions should be taken to make certain that sparks or hot slag—from cutting operations particularly—do not reach the combustible material and thus start a fire. If the work cannot be moved, exposed combustible material should, if possible, be moved a safe distance away. Sweep floors clean and if combusible, wet them down before starting work. Wooden floors should preferably be covered with metal, sand, or other suitable non-combustible material where sparks or hot metal are likely to fall. Brick is not suitable unless all crevices are filled with sand. Wherever there are floor openings or cracks in the flooring, make certain that there are no highly combustible materials on the floor below, which would be exposed to hot metal or slag that might drop through the floor.

5. Observe the same precautions outlined in Rule 4 with regard to cracks or holes in walls, open doorways and open or broken windows. Use sheet metal guards or asbestos curtains where needed. Make sure that the guards and curtains are adequate. Because hot slag may roll along the floor for considerable distances, it is important when using asbestos blankets as curtains that no openings exist where the curtain meets the floor.

6. When it is necessary to do welding or cutting close to wooden construction, or in locations where combustible material cannot be removed or protected, small hose, chemical extinguishers or fire pails should be conveniently at hand.

7. Whenever combustible material has been exposed to molten metal or hot slag from cutting operations, a man should be kept at the source of the work for a half hour after completion, to make sure that smoldering fires have not been started.

8. All welding and cutting equipment should be kept in good order. Use good hose and renew it when necessary. When hose is worn near the couplings, cut off a few inches and renew the connections, making sure that they are tight. Good connections between regulators and cylinder valves are important. Torches or blowpipes should never be hung from regulators or across the tops of cylinders. Only cylinders which com-

"Take no chances. Everybody loses from a fire, employer and employee alike. It is safer and much more to one's credit to keep fires from starting than to put them out afterwards. Remember, an employee is always some sort of an example for his helper or others less experienced.

"Men who are to be entrusted with welding and cutting jobs should be men who handle oxy-acetylene equipment safely and sensibly. They should be men who know that it is just as important to prevent fires as it is to prevent accidents, and that a small fire is a potential big fire that will cause severe hardship to his employer and his fellow workmen as well as himself.

"An operator should never hesitate to talk things over with his superior, even if he feels fairly sure that he is taking the right steps to prevent fires."

—J. I. Banash and H. F. Reinhard

ply with Interstate Commerce Commission shipping container specifications and which are equipped with safety devices approved as to type and location, shall be used for any compressed gas.

9. For the installation and operation of gas systems for welding and cutting, the regulations of the National Board of Fire Underwriters should be followed.

Rules, without clear thinking and the exercise of sound judgment, are not always effective. We therefore add:

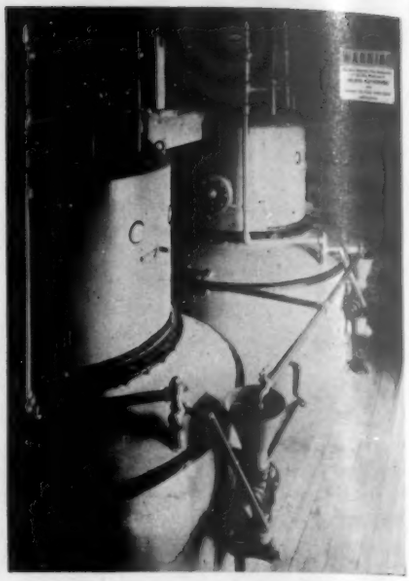
Take no chances. Everybody loses from a fire, employer and employee alike. It is safer and much more to one's credit to keep fires from starting than to put them out afterwards. Remember, an employee is always some sort of an example for his helper or others less experienced.

Men who are to be entrusted with welding and cutting jobs should be men who handle oxy-acetylene equipment safely and sensibly. They should be men who know that it is just as important to prevent fires as it is to prevent accidents, and that a small fire is a potential big fire that will cause severe hardship to his employer and his fellow workmen as well as himself.

An operator should never hesitate to talk things over with his superior, even if he feels fairly sure that he is taking the right steps to prevent fires.

The Inspection Department of the Associated Factory Mutual Fire Insurance Companies urges that before welding or cutting is performed at a point not regularly set aside for such work, permission be secured from some specified responsible person such as a superintendent or foreman. We heartily subscribe to this, and we further urge that no such work be performed without the knowledge or consent of the person responsible for the department in which the work is being done.

A fire may radiate heat but it radiates very little credit to the person or persons responsible.



Acetylene generators must be given special consideration when freezing temperatures prevail

Winter Care of Welding Equipment

The oxy-acetylene process frequently involves the use of equipment in which water is essential to the operation, or in which water may be present due to condensation. Therefore, before and during the season of the year when freezing temperatures prevail, such equipment must be given special consideration and care. This is particularly true where acetylene generators and accessory equipment are concerned.

The importance of preventing acetylene generating and distributing systems from freezing cannot be too strongly emphasized. If freezing does occur, it is of vital importance that the situation be handled quickly and intelligently.

Acetylene when mixed with air in certain proportions is explosive if ignited. In the routine use of most acetylene generators, air-acetylene mixtures are created every time the generator is recharged. These *known* air-acetylene mixtures can be handled with confidence, however, since they are quickly eliminated by following the manufacturers operating instructions which are furnished with each generator. It is the *accidental* or *undetected* air-acetylene mixtures which are hazardous and which must be prevented.

The freezing of water in acetylene equipment can cause physical damage which may result in the formation of an air-acetylene mixture. Such physical damage may be readily apparent. On the other hand, it may be of such a nature that it is not so easily detected. Even though there is no actual physical damage, freezing may affect a generator and other equipment so that the normal operating routine is unsafe.

The freezing of acetylene equipment may be due to two causes: (1) freezing of water used for specific purposes in the equipment, or (2) freezing of water that has condensed out of the acetylene.

The principal types of acetylene equipment subject to freezing are: generators, flood lights, hydraulic back-pressure valves, regulators, relief valves, line shut-off valves, distributing piping and vent pipes, and hose. Of these, only generators, flood lights and hydraulic back-pressure valves regularly use water as a necessary factor in their operation; all, however, are subject to freezing of condensed moisture.

The correct winter care of acetylene equipment has three objectives:

(1) To prevent the possibility of freezing in the first place.

(2) If freezing does occur, but has not caused any damage, to thaw out the equipment and put it back into service in the safest possible manner.

(3) If the equipment has been damaged by freezing, to handle the situation in such a manner that the trouble can be corrected and the damage repaired in the quickest possible manner.

There are so many different types and combinations of equipment which may be involved, and so many individual circumstances or local conditions which may arise, that no completely specific set of rules can be evolved to prevent or handle all cases of freezing. Each situation requires individual consideration. There are, however, certain general precautions which may be applied to practically any equipment.

The only completely satisfactory method of protecting acetylene equipment from freezing is to use, store or install the equipment in a room or building in which a temperature of at least 40 deg. F. is always maintained.

Obviously, however, this will not always be possible, as in the case of a broken down heating system, hydraulic back pressure valves used in a plant which may be temporarily shut down, or, for example, in the case of a portable generator used on a pipeline job. Such cases require special treatment to prevent or handle freezing, and, the natural reaction of a generator user is to

*Reprinted from "Oxy-Acetylene Tips," October, 1937.

inquire, "What should be done in such circumstances?"

If any conditions should arise which make it impossible to protect the equipment by correct housing and heating, or if any conditions arise which leave any doubt as to the safe method of procedure, the wisest course is to communicate with the manufacturer of the equipment, or his representative. The manufacturer will supply special instructions, recommendations and, if necessary, additional assistance.

Arc-Welded Oil Casing Eliminates Screwed Joints

By J. ARTHUR SOHN*

EARLY in 1937 The Carter Oil Company, a subsidiary of the Standard Oil Company, began experimenting with butt-welded casing in the W. T. Miller No. 4 well located in the Crescent Pool, Oklahoma. In this type of welding the casing is in a vertical position when butt-welded, in contrast to pipeline welding where the joints are most always in a horizontal position. Last February, The Carter Oil Co. welded surface casing on two of its wells, one string of 250 ft. and another

Pick-up and line-up clamps designed by Carter Oil Co. engineers for arc welding of casing

of 570 ft. The surface casing is the short string of large size pipe which is run soon after drilling begins to prevent cave-ins of the soft formation near the earth's surface. Casing is run also to prevent contamination of the fresh water supply by the drilling mud.

During the last 15 years there have been only isolated examples of welded casing. Little was done in this particular application until recently, when some California drilling operators ran long strings of slip-joint casing in which the collars were welded to the joints. However, this method did not possess all the advantages of a straight butt-welded connection. The slip-joint is more expensive because it involves the use of couplings and the joint efficiency is not as high as butt welding two beveled pipe ends together. Welders on the job had to practice quite a bit to gain speed and technique in welding vertical casing, but they succeeded after considerable practice in making butt welds stronger than the pipe itself.

Charlie Morgan, an old timer in the Oklahoma oil fields was quite amazed at his first visit to an oil well drilling operation where arc welded casing was being strung. Here is how an observer reports Charlie's experiences:

"Tell me, Joe (the engineer), whut are the boys doing in there?"

Left—Lining up two lengths with special clamp to hold them in proper alignment. Right—With the clamp removed, the welders get to work

Before the clamp is removed, the casing is tack welded at several points—Next step is complete welding of butt joint

"Man, you're just in time. Those four fellows are arc-welders, and you're watching the first long string of butt-end, welded casing ever run in the Mid-Continent area."

Casing, as Charlie of course knew, prevents cave-ins, leakage of oil and gas from the hole and seeping in of water. It also provides a permanent opening to the oil-bearing formation.

"Come up and watch the welders," the engineer invited. "You'll have to wear these goggles, though, because the arcs will burn your eyes if you don't."

Charlie eyed the goggles with suspicion for a moment before slipping them over his head. He followed up

*Abstracted from an article written by Mr. Sohn and printed in a recent issue of "The Lamp," a Standard Oil internal publication.

the steps to the derrick floor, and the two men sat down by the fire in the doghouse, their attention focused on the unusual sight.

Screwed pipe with collars and threads had generally been used to line the well holes, there being no other method of getting the pipe into the hole. Joint by joint, the casing would be raised to a vertical position above the hole, screwed into the pipe already in, then lowered. This screwed casing had proven satisfactory and both its manufacture and use had been developed to a high art. One of the prettiest sights in the oil fields, from the standpoint of teamwork and timing, is the running of casing, the joints being raised, stabbed (centered), spun or screwed, and lowered with a minimum of lost time and energy.

"How come you're trying this new-fangled idee, Joe'"

The young engineer grinned, "I'll tell you, Old-Timer, it's because making threads and couplings has been a necessary evil to the pipe makers. It took more money for mill machinery, more men to operate it and inspect the finished pipe. Pipe can be made in a jiffy, you know, with those machines, but the addition of threads and couplings complicated things. Each joint had to be treated, then minutely inspected. Any rejected lengths had to be cut up and run through the whole works again. When the demand for that type of pipe is large, the extra time needed to handle threads and couplings makes the manufacturer fall behind in shipments and we can't get our pipe. All of this costs money, Charlie, and the oil producers have had to pay the difference."

The old man still looked skeptical, especially when a shower of sparks fell on him. The engineer went on:

"You know as well as I do that deep drilling is tough even on well made couplings. With the higher pressures there's been plenty of leakage. Furthermofe, the couplings and threads are easily damaged while being moved around or even in running the well, causing still more leaks. The relative strength of the joint composed of the threads and couplings is about 65 per cent of the strength of the stock of the pipe. So quite a chunk of what the producer pays goes for the joint, which is only two-thirds as strong as the pipe."

There would have been danger of fire under the old system of cable tools, the engineer explained, since there was always the chance of gas escaping from the well. But with rotary tools the hole is usually safely loaded with mud so that there is no chance of fire.

"And Charlie," he added, "these welders are good, but their equipment is even better. They've got to be good when you think that, in running a long string, the top joints must hold as much as 6,000 ft. of pipe suspended in the hole. Besides, the steel in this casing is especially made for welding."

The engineer led him to a hole about seven feet away from the well. "This is a special rat-hole, Charlie, just deep enough to hold a 40-ft. length of pipe," he explained. "On the runway next to the derrick floor, a 1½-in. manilla cat-line picks up another joint of pipe and holds it above the length in the rat-hole. The two ends are lined up by a special line-up clamp designed and made by the Carter Oil Co.

Charlie was visibly interested in all this and the engineer went on: "Two welders, with portable arc-welding units, weld the two joints of pipe together as the next step. Then the welded lengths of pipe are raised from the rat-hole, lined up and welded to the pipe in the well-hole by two more welders. At all times there are four welders working in unison, two at the rat-hole and two at the well-head.

"I'll admit, Charlie," the engineer conceded, "that it takes 27 hours to run the welded casing in the well, as against eight hours for a string of screwed casing. But we expect to cut this time in half with further welding improvements and more experience by the welders and drilling crews. Even today we save money on the whole job because our pipe costs us less."

Oil Well Casing Now Being Welded

By H. S. CARD

IN THE production division of the petroleum industry the welding of oil well casing pipe seems destined to become an accepted standard operation. Yet in spite of the advantages which are offered by a satisfactory job, there are numerous special problems involved which differentiate this application from the many pipe welding jobs that have been completely approved. Some of these problems affect the welder only indirectly. One of these is the fire hazard when gas is present. This was a source of worry at the beginning but it was found to be adequately controlled by the use of heavy mud. In rotary drilling the weight of the mud can be controlled, and as a hole is kept full of mud at all times operators are able to control the gas, except in a very few fields. These more hazardous fields are known and welding is not attempted in them. However, the same hazard exists in other methods of runing casings, because sparks may be thrown by threaded and coupled pipe and by tools inside the casing. Another problem arises from the fact that deep well casing pipe is frequently made of medium carbon steel of high strength and the high carbon content of the material makes necessary special procedures which slow up the work, and time is precious in oil field work. However, if other difficulties are overcome, which appears to be a certainty, it is probable that casings of more easily weldable quality will be made

Arc-welders joining two lengths of steel casing on the derrick floor

Picking up the casing length—"Stabbing" the casing

available without undue sacrifice of strength.

It should be obvious that a considerable portion of the advantage gained by using the higher carbon steels is lost by the reduced efficiency of the pipe wall where threads are cut, and this could be more than offset by using material which would permit of developing 100% efficiency at the joint. Success in this field will therefore depend on perfecting operating methods that insure gas tight joints at a welding speed comparable to running a string of coupled joints.

Electric arc welding is claimed to be preferred by most contractors, because of the greater ease of making a double bead weld, and of minimizing the heating of the parent metal. The arc weld is said to suffer less quenching effect when the finished joint is lowered into the well, and that is of great importance to the contractor, who wants to go down with the casing without loss of time.

Oil men are interested in two qualities that are inherent in a good pipe weld. One is that having been made leakproof it stays leakproof because there is nothing about it that can work loose. Another is that it can be made permanently as strong as the pipe itself.

The welding problem, then, is to do a 100% job and do it fast. Some of the earliest welded strings took as much as three times the running time as equivalent coupled strings, but that time differential has been almost completely removed. After a little more experience has been gained there will be no question as to the speed of running an arc welded string.

It might be well to observe that the petroleum industry is interested in this subject because it expects to get a better well casing, just as welding has made possible better pipe lines, better pressure vessels and better storage tanks, at no increase in cost. Consequently there has been a large amount of research done on this casing subject, in which welded joints of many kinds have been subjected to every known test, and working procedures combined with new mechanical devices to reduce the running time.

Much interest has naturally centered in the subject of joint design. In general the choice is between a butt joint and some form of the bell and spigot type of pipe joint, and both types are being used. Kane Boiler Works, of Galveston, Texas, has been working on this problem for over fifteen years, starting with a large diameter pit casing for water wells and following down to the small diameter (5-½ in.) casing used for the mile-deep oil wells of the present day. This company has patented a bell spigot type of joint which has an inside bevel on the lip of the bell. The claim made for this design is that full penetration through the root of the well is obtained on the first bead, which is refined in its structure by the second, or sealing, bead. There is of course no chance for weld metal to protrude into the pipe, so high heats can be used, which in turn helps to reduce the welding time required. Records of some 200 strings of casings recently run by this company in sizes from 5-½ in. to 18 in. in diameter, and totaling well over 40 miles, show that the time has compared very favorably with that of coupled joints, and that the casing cost has often been appreciably lowered. Over 600 strings of oil well casing have been run to date, averaging some 1600 ft. in length. The average length of string is increasing because they are now running some strings of over 6,500 ft. and will very shortly run some 7500 ft. strings. Faster work can be done when circumstances warrant the increased cost of equipment and overhead for doubling the number of welds made at one time.

Continued study of the mechanical problems and welding problems involved will undoubtedly lead to reduced costs and better welded casings. The amount of welding involved is considerably greater than in the case of overland pipe lines. In 1936 there were over 20,000 oil and gas wells drilled and cased at an average depth of about 4,000 ft.

Alignment of casing before welding—Completed weld of 18⅝-in. casing

Get H.O.T. on Welding

Hot Sparks

Drive the way you want the other fellow to drive!

It is just as bad "etiket" to talk business when fishing, or playing golf, or any other form of recreation, as it is to talk about such things when you're talking business with a man. There isn't time for either, when doing the other.

There's a real art in knowing how to loaf. It's an important one we should all learn how to do well and gracefully.

Fall!

Well here we are with vacation over, I sure had a dandy; it was perfectly swell, with plenty of surf fishing, swimming, and a grand rest down East at Newport, R. I.—so now I'll start pounding the highways and byways around the old territory expecting no longer to be greeted with the usual "Mr. So and So is on his vacation, sorry!" Funny people say that when you really know they don't give a "damn." But now with Fall comes football games, hunting, and conventions. October brings The National Metal Exposition and American Welding Society Convention in Atlantic City, N. J.

Really, The National Metal Exposition is a show long remembered because it gives you up to the minute knowledge of what is new in your industry. And "youse guys" that don't belong to the American Welding Society yet and are still stalling around about it, get wise to yourselves and open up that old pocket book. What do you care if a few moths do fly out of it? You'll find that if you're in the welding business you really belong in the society. Local meetings are well worth attending and there have been a lot of new chapters started this past year. You "guys" down around Cincinnati better sign up, and I'll see you at some of the meetings this winter. This is one of the new chapters so get behind it and put it over big. The "guys" starting this chapter are really grand fellows.

Then in November comes the International Acetylene Association convention in Birmingham, Ala. Now there's a town to visit. Particularly you guys up North that have never been South. I calls it one swell and very interesting city. Now these "lugs" that run this I.A.A. convention sure give you your nickel's worth, so take it from the Old Maestro, don't pass it up, if there is anyway you can manage to get there. Yea, Man! Remember that good old southern hospitality and them pretty southern gals.

The Job Welding Shop

I get many letters from shop owners asking for welders, or for advice as to picking good welders. And from welders, a lot of them want work in a job shop. So I want to go on record about this very important subject in a sincere effort to help both the owners and the welders. Last Sunday up in Toledo Ohio, I was out skeet shooting with Art Rack, one of the real old timers in the game, and now owner of The Toledo Welding Co. And Art hit the nail right on the head, that the most important qualification for a job shop welder is a lad who is steady—on the job every day—regardless. And Art says that he fires the guy that lays off a day unless he's really sick, no matter how good a welder he is.

Talking about practising what Art preaches, one of his men (Walt) has been with him for twelve years. And that is really the important thing, because then your customers will know they can depend on your shop, and you. So you "guys" that are looking for job shops remember that, and unless you're willing to be—steady—keep out of the job welding business. And you shop owners will do as you jolly well please, anyway, so just go ahead and do it.

Every now and then some customer waltzes into your shop and asks you to quote on a job. You go ahead and figure it out and he tells you he can get it done a lot cheaper; in fact "somebody or other" will do it for "so much." Brother, about 99 and 44/100 per cent of such chatter is a lot of horse feathers. So lend a very deaf ear to it, and stick to your price. Let 'em go down the street to the other shop, what do you care for business that you can't get at your price. But 'phone the other shop and tell him honestly the price you've quoted. He'll play fair with you and most likely will bid your price on the job, or higher, and you'll be getting your customer back, because your friendly rival will expect you to do the same. You "guys" get together and try it; you'll find that it really works in nearly every case. Don't play your customer for a sucker, and don't be one yourself.

"The Pics"

A couple of weeks ago I was talking with Dr. Jean Piccard—remember him, he's the stratosphere guy. Well he was telling me his plans for another flight. This time he wants to go straight up at least 17 miles. And he's going to use 2,000 little balloons. These are about three feet in diameter. He plans on using an all welded aluminum gondola—that's the seven-foot diameter ball he will ride in. He tells me he's going to give welding plenty of publicity. And believe you mister it will be worth plenty, because his life depends on those welds. It sure should be proof aplenty to those you are selling welding to, that welding is what they need.

Now Jean hasn't all the bucks in the world, not even his share of it, because after all he is just a poor college prof. But he is a grand "guy" in spite of his looks—he can't help those any more than you can help it that you're the best looking "guy"

in your town. He is doing a really swell job in his research work, that some day will help the world in general. But, be that as it may, and believe it or not, but right now because he is a big booster for welding and he has to do these things on money that people contribute, I think it would be swell if you "guys" would back him up by contributing a buck or two to help him in his work. *DON'T SEND CASH, PLEASE!* Send a check and make it out to Dr. Jean Piccard. Send it to me at 359 Park Ave., West, Mansfield, Ohio. I'll forward it to him with a nice letter wishing him many happy landings as an expression from the welding fraternity of our faith in him and thanking him for his faith in welding. Really, you'll feel swell all day long in the thought that you have, in a very small way, contributed to something worthwhile.

• • •

The thought for the month: Isn't it swell, son, to have the world to dream about!

The Ambassadore
of Hard-Surfacing

(*P.S.*) *If you don't belong to the American Welding Society, be sure to join up today. Send me a postal and I'll personally mail you an application blank. Remember in October, it's the National Metal Exposition at Atlantic City and in November, the International Acetylene Convention in Birmingham.*

A Thought for Every Day

My swell boss, E. L. Mills, sent me the following the other day, because it is so perfectly grand, he felt sure you'd all enjoy reading it also:

THE TEST OF A MAN

There's little satisfaction to be gained
from doing things
That hold no difficulties; it's the tough old
task that brings
Keen sense of worth and power to the
man who wins the fight;
His failures test his courage and his problems prove his might.
Until a man has conquered loss and overcome defeat
He cannot fully understand just why
success is sweet.

I'm thankful for my disappointments, for
the battles lost,
And for mistakes that seem to charge an
overwhelming cost;
I'm thankful for the days of doubt, when
it was hard to see
That all things work together for the good
that is to be;
I'm glad for all that life has brought, because today I know
That men must brave adversities if they
would greater grow.

—O. Lawrence Hawthorne.

The Thought for the Month: There's no use racing to get nowhere.

A Cylinder Truck

Some time ago we ran a drawing in this column showing details of the following pictures. Feeling much as the Chinese do, that one picture is worth ten thousand words—here's thirty thousand words for you guys, all at once. Don't you feel very glad that you can just look at it and don't have to read it?

This little cylinder truck has certainly worked out satisfactorily. This one has been put on springs instead of using rigid wheel construction.

Simple two-wheeled trailer for carrying gas cylinders

The springs, axles and wheels are from a 1927 Chevrolet front end. The balance of the construction is ordinary steel pipe, welded together neatly, and a couple of pieces of 3/16-in. plate.

The complete trailer weighs 260 lbs. and is easily pushed around by one man and trails along at 45 and 50 miles per hour behind a passenger car. It is a swell outfit for any shop when rigged up as shown. Total cost of material for this job, including tires (second-hand ones) was in the neighborhood of $10. The welding was done during spare moments in the shop when the welders would ordinarily have been idle.

Hope I see some of these rolling down the highways and byways, as I find my way around.

A Flashback!

"Pat" (age four)—he's the heir to the Ridlon millions—and I were having breakfast together the other morning, when suddenly he looked up from his oatmeal, and said:

"Dad, I think you're swell!"

"Go on with ye, lad," was my reply. "I think you've kissed the Blarney Stone!"

"No!" was his quick retort, "I kissed you!"

Strange how much real softness can be found, even in such a hard business.

In my den there is growing a rather interesting galaxy of you gents in the welding industry. But there is still one hell of a lot of wall space yet to be filled and I'd more than appreciate having pictures of my good friends and pals to put up on that wall. Thank you!

Time protects us from ourselves—it is the little things that cannot wait that keep the wheels churning.

In this world of transient things—where everything must yield to the laws of change—it is strange that one thing, love, nearly always remains constant and unchanged.

Let an unbeliever have a close-up of the peaceful actuality of a well-beloved and good person's death and he will begin to reason differently.

Most of my days pass very quickly because I fill them with myriads of things—work to do—but there are times when I catch my breath in sudden loneliness.

One must make no little plans, son. They have no magic. Even now you should aim high.

I've found that love will not be confined—it beats its way through everything I do.

It isn't easy to part from a true friend calmly.

Dreams are such fragile, lovely things—it's hard not to let them ride one's heart.

Hoy

GEORGE E. BERRY, of the United States Bureau of Marine Inspection and Navigation, Pittsburgh, Pa., recently inspected two pressure tanks of welded construction at Oakmont, Pa. These tanks will be installed on two hulls now under construction at the Great Lakes Engineering Works, Ecorse, Mich., for the Ford Motor Company. The tanks are 29½ in. in diameter and 9 ft. long.

UNITED STATES ENGINEERS of the Memphis district recently took bids for the construction of 15 welded steel dredge pontoons. These pontoons will be 48 ft. long, 18 ft. wide and 2.10 ft. deep and will require approximately 260 tons of steel plates and shapes. They will be equipped with tracks for the support of the dredge pipe. Delivery is to be made within 45 days after the contract is awarded, after which a penalty of $3 per day will be enforced.

Structure of Hard-Surfacing Weld Deposits

By A. G. DE GOLYER

Manager, Weld Rod Dept., Ludlum Steel Co., Watervliet, N. Y.

THE STRUCTURE of a weld deposit of hard-surfacing metal is an important factor in determining the extent to which such metal will resist wear.

Certain parts of machinery and equipment wear, or, stated more accurately, lose their original dimensions mechanically, through three general causes: (1) abrasion; (2) deformation by impact or compression; (3) by a combination of abrasion and impact, or abrasion and compression. Each of these general types of wear imposes different physical conditions and, consequently, a different type of weld metal structure is required to efficiently and economically retard wear from each cause.

Extensive study of wear conditions in a large number of industries led to the development of a series of new ferrous-base alloys intended exclusively for the deposition by welding of wear-resistant overlays or inlays. Weld deposits of these alloys have physical properties and characteristics specifically adapted for resisting the different forms of wear.

This investigation of hard-surfacing problems disclosed the fact that in a great many cases, weld rods were selected solely on the basis of the initial hardness of the weld deposit. This practise is not to be recommended, as a mechanical measurement of hardness seldom gives an accurate indication of the degree to which weld metal will retard wear.

Since the main objective of hard-surfacing is economy, it is essential that the surfacing alloy be selected on the basis of a combination of physical properties and structure of weld metal in order to secure the full advantages of economy offered by the process. This implies, of course, a thorough understanding of the wear conditions imposed by the operation.

The structure of many hard-surfacing deposits comprises essentially a hard constituent and a much softer constitutent which functions as a matrix. For example, one of the constituents may have a hardness of 800 or 900 Brinell, while the hardness of the matrix will range from 185 to 250 Brinell. The structure of such a deposit is more or less comparable to the structure of an abrasive grinding wheel. The latter consists of particles of silicon carbide, or some other hard material, bonded with a material having much lower hardness. The objective in the case of the grinding wheel is to have the matrix wear rapidly, in order that the partially worn hard particles will be rapidly dislodged and another surface of sharp cutting faces be exposed.

How Grinding Wheel Works

The grinding wheel removes metal or other material by means of accelerated abrasion and it is generally understood that comparatively rapid wear of the wheel is a necessary evil. The objective of a hard-surfacing deposit is to retard wear on the area which has been surfaced, consequently a weld structure comparable to that of the grinding wheel is not well adapted to this purpose. For that reason, the physical properties of the matrix of a hard-surfacing alloy are quite important. On all operations imposing abrasive wear the matrix should have the property of retarding wear for an appreciable length of time. At the same time the matrix must have sufficient strength and toughness to retain the super-hard particles in order to avoid accelerated wear, as illustrated by the grinding wheel.

It should be quite evident that a different matrix is required to successfully and economically resist each of the different forms of wear. In the case of weld deposits the best and most direct method for securing the most suitable matrix is by regulating the essential components of the alloy. The structure of a weld deposit intended primarily for resisting abrasive wear should comprise a relatively high percentage of superhard particles, in a more or less finely divided state, dispersed as uniformly as possible through a matrix having a relatively high degree of hardness, and, at the same time, sufficient strength and toughness to retain the hard constituent for a considerable length of time.

It is generally recognized that a weld deposit having an initial hardness of from 700 to 800 Brinell is more brittle than an ordinary carbon steel having a hardness of 185 Brinell. However, it is perhaps not so generally recognized that the relative brittleness of hard-surfacing alloys having a comparable measure of hardness depends largely upon the respective structures of such deposits.

On operations imposing both abrasion and impact, or abrasion and compression, the best results, in general, will be obtained with a weld deposit having a structure which offers an appreciable degree of wear resistance and, at the same time, a relatively high degree of resistance to deformation under impact, or compression. The matrix material should have a hardness which is not more than 100 or 200 Brinell num-

bers lower than that of the hard constituent. Furthermore, the ratio of the matrix constituent to the hard constituent should be much higher than in the case of weld deposits intended primarily for abrasion resistance.

Weld deposits intended to resist impact or compression, either of which may be accompanied by some abrasive wear, should have a much more uniform structure than either of the above types of alloys. Fractures of such deposits should show

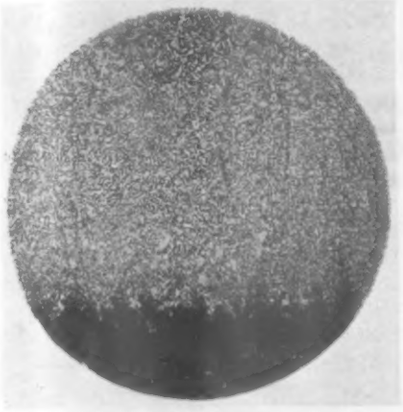


Fig. 1—Type of weld metal structure well adapted to resist abrasion

a relatively fine grain structure and it will be obvious that weld metal intended to resist deformation must have a comparatively low degree of brittleness.

A group of new ferrous-base alloys comprising three distinct compositions has recently been announced. These alloys are in the form of electrodes for hard surfacing and each one is intended to give a deposit especially suitable for retarding one of the three general forms of wear.

One of the alloys contains approximately: molybdenum 17 per cent, tungsten 5 per cent, boron 2.10 per cent and carbon 0.35 per cent. Another contains approximately: chromium 14 per cent, molybdenum 2 per cent, boron 1.10 per cent and carbon 0.35 per cent. The third alloy contains: tungsten 5 per cent, chromium 4 per cent and a minor amount of boron. It will be noted that these alloys contain less than 0.50 per cent carbon, a much lower percentage than is found in virtually all other hard-surfacing alloys.

The type of weld metal structure which is well adapted to resist abrasive wear and also to withstand varying degrees of impact or compression is illustrated in Fig. 1. A type of weld metal particularly well adapted for resisting both abrasive wear and a high degree of impact or compression is illustrated in Fig. 2. A comparison of these photomicrographs illustrates clearly the marked difference in the two types of weld metal. The deposit shown in Fig. 1 consists of a high percentage of a hard constituent, in a finely divided form, uniformly dispersed through the matrix. The hardness of such deposits is more than 725 Brinell. The structure illustrated in Fig. 2 consists of a much lower percentage of super-hard constituent than is present in the other metal, with a consequent increase in the ratio of the matrix. The hardness of such deposits is more than 625 Brinell. It will be observed that the structure of both deposits is quite uniform and entirely free from massive segregates of hard, brittle constituents.

Manganese Steel

The advantage derived from selecting a hard-surfacing electrode on the basis of both physical properties and structure of the weld metal is illustrated on operations involving the hard-surfacing of 14 per cent manganese steel. There are, of course, many operations on which it is probably not economical to hard surface such metal. On the other hand, many dredging and other operations impose an appreciable degree of abrasive wear. On these operations wear from abrasion may be excessive. In such cases the use of the proper hard-surfacing alloy will result in much greater service life of the manganese steel.

One case will serve as an illustration. A large hydraulic dredge operating in sand, gravel and clay with occasional stratas of bog iron and numerous boulders of varying sizes, employed manganese steel cutter blades. The average service life of such blades was approximately 48 hours. A set of six blades cost $430. The same type of blades were hard-surfaced with the chromium-boron alloy at a cost of $156 for materials, labor, etc., giving a total cost of $586 for a set of blades. The average service life of the hard-surfaced blades, under the same conditions, was approximately 130 hours. The hard-surfaced blades thus gave a direct saving of slightly more than $100 each 24-hour day. The operator of the dredge estimated that a further material economy was derived by reason of the fact that the hard-surfaced blades retained dimensions nearly approximating the original.

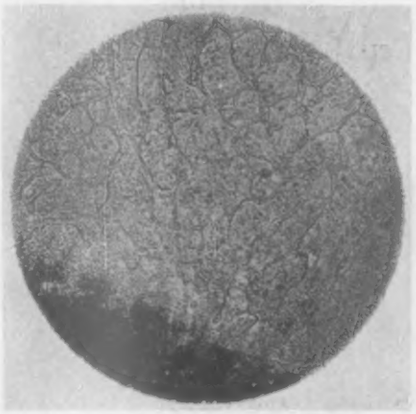


Fig. 2—Type of structure well adapted for resisting abrasion and impact or compression

Hard surfacing cannot be satisfactory nor economical on every operation which imposes severe wearing conditions. However, it can be employed to very real advantage in a large number of widely diversified cases, providing that a reasonable amount of care is exercised in selecting the welding alloy best adapted to resist the type of wear encountered.

Gold Medal to Be Awarded for Best Published Paper

The Lincoln Gold Medal was accepted by the American Welding Society early this year for presentation to the author of the best paper on any phase of welding published in the *Journal* of the American Welding Society.

Lincoln gold medal will be awarded to author of best technical paper

The medal is being offered by J. F. Lincoln, president of The Lincoln Electric Co., Cleveland, O., as a stimulus to the preparation of worth while contributions to the art of welding.

There are no restrictions as to subject matter of papers eligible to compete for the award. The paper may be on the electric-arc process, gas welding, resistance welding, or any

other form of welding within the scope of the American Welding Society. The paper may be one read before any sectional meeting of the Society or at the general fall meeting, but it must be published in the Journal of the Society between the dates given above, to be eligible to receive the medal.

The decision as to the best paper will rest with a committee of the Society selected by the President. This committee consists of Col. G. F. Jenks, chairman, K. V. King and F. E. Rogers. The medal will be presented during the annual convention of the American Welding Society in October.

Huge Radiograph Checks Possible Welding Defects

Huge X-ray machines, new being used in the plants of many well-equipped producers of pressure vessels such as distillation equipment, boiler drums, heat exchangers, condensers and other heavy welded steel units, have made the inspection of welds in plates up to four inches thick a standard practice. Such a machine recently was installed in the plant of the Blaw-Knox Company, Pittsburgh, Pa. The new machine embodies the most recent improvements for industrial work. Radiographs made with it clearly show defects and imperfections having a quantitative thickness greater than two percent of the depth of the weld.

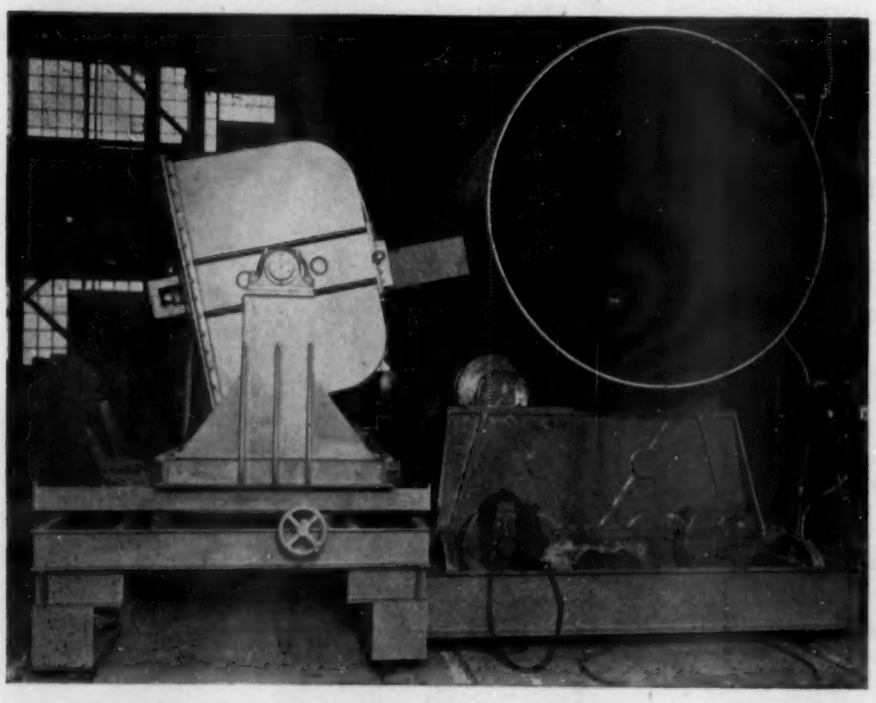
Included with this equipment is a grid. The purpose of this grid is to eliminate all secondary or scattered rays, thus producing a sharper or more definite picture. Defects will be shown when X-raying heavy plates by the use of the grid, which otherwise could not be seen.

Using standard radiographs approved by the American Society of Mechanical Engineers for comparison, the equipment makes possible a definite check on the perfection of welded work for the protection of customers and, in addition, provides a permanent record of each part of every weld.

The machine covers a broad range in the amount of amperage and voltage used. While it is built to operate at X-ray tube currents of from one to ten milliamperes, it uses voltages up to a peak of 400,000 volts.

It contains two units mounted on a truck. These are the control panel, which is placed in a lead-lined booth which provides absolute protection for the operator from contact with the X-rays; and a head, so mounted that it may be completely rotated on either its horizontal or vertical axes. This makes it possible to place the head on the weld in such a position that the X-ray beam is perpendicular to a tangent drawn through the center of the welded seam and perpendicular to the X-ray film.

X-Ray machine provides permanent record of every bit of welding on a job



In operation, the welded vessel is permanently marked at intervals within the range of each X-ray picture. In addition, lead numbers are mounted on the work in order to provide a corresponding record on the X-ray negative. The head of the X-ray machine is placed at a suitable distance from the weld, and the holder, containing the film between two intensifying screens in a metallic frame, is placed on the opposite side of the weld.

Controls permit the selection of any desired voltage to conform to the thickness of the material being inspected. Lead shutters, ½ inch thick, are mounted at the point in the head where the X-ray beams emerge. This permits the machine to be moved from point to point without turning it off between exposures and has the effect of eliminating delays incident to the adjustment of voltage.

Attached to the opening in the head is a lead lined pyramidal cone, so shaped that it just covers the opening at the housing of the head, while flaring to dimensions slightly larger than the length of the X-ray film. This gives absolute restriction of the X-ray beam within a definite area.

The head consists of an oil-filled tank, in which are located the equipment for generating high voltages and the X-ray tube. The oil is circulated by means of a pump and filter which maintains the equipment at a safe operating temperature.

Since any variation in thickness greater than two per cent of the depth of the weld will appear as different densities on the X-ray film, it is possible to detect porosity, slag inclusions, or other defects serious enough to require rejection of the work. In the cases of rejection, the defective welds are cut out and the work re-welded and again inspected.

THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION will hold its Fifteenth Annual Convention at the Greenbrier Hotel, White Sulphur Springs, West Virginia, October 26th to 29. General business sessions will be held in the morning, leaving the afternoons free for special forums, conferences and group meetings.

Brief abstracts of papers presented at

Eighteenth Annual Meeting

Of American Welding Society, Atlantic City, N. J.—Research results will aid engineers in designing structures for welding

IN THIS issue we present several abstracts of the technical papers presented at the 18th annual convention of the American Welding Society, held in Atlantic City, October 18-22 inclusive. It is our plan to publish a selected group of these papers in our November issue.

Recent advances in welding research and developments in welding procedure and related subjects were described by more than a score of authorities in the welding field. The papers presented at Atlantic City covered a wide range of engineering problems including such subjects as: Non-destructive magnetic tests for welded seams; Fatigue tests of butt welds and structural members; Power supply of electric welding; Stainless steel applications to pressure vessels; Welding of oil tankers; Building up of locomotive driving boxes; Heat effect of welding, etc.

A-C. Non-Destructive Test for Welded Seams

By W. B. KOUWENHOVEN and A. E. VIVELL*

If only the human eye could see through and into metals as it can see through glass! If we could see into metals we could be sure our castings, welds, and other metal products on which we so confidently rely, contained none of the defects which on rare occasions, it is true, we discover as the result of accident. For we cannot afford to hunt for defects by cutting our product to bits and pasting all the bits together again.

One solution to man's desire for an eye to see into metals is the X-Ray, but this solution has several commercial limitations. The "eye" developed by Professor Kouwenhoven of the Johns Hopkins University, in collaboration with A. E. Vivell of Princeton University, is based on the principles of magnetism and may be termed the *"magnetic eye."*

In this method the welded seam is magnetized by a powerful alternating magnetomotive force. For welds less than ¼-in. thick, 60 cycle current may be used to insure penetration of the magnetic flux. Two search coils connected in opposition are placed on the seam so that any stray field which may be present cuts their windings. The shape of the wave of electromotive force induced in the coils is observed by means of an oscillograph.

Using this apparatus on purposely defective welds, Professor Kouwenhoven and Mr. Vivell found that, given proper conditions, which they discovered, unique changes in the shape of the wave observed on the screen of the oscillograph are created by flaws. Instead of a curve having characteristic kinks, typical of a sound weld, the defective weld produces well-defined irregularities in the wave. As the search coils move along the weld, flaws even ½ in. deep in the weld are revealed at once.

*Johns Hopkins University and Princeton University respectively.

Effect of Welded Top Angles On Beam-Column Joints

By INGE LYSE and GLENN J. GIBSON*

For the past few years one of the leading engineering laboratories in the country—the Fritz Engineering Laboratory—has been conducting an exhaustive investigation into welded steel building construction. The latest report on this research has been prepared by Professor Inge Lyse and G. J. Gibson, of Lehigh University.

The investigation at Lehigh deals with the rigidity of welded buildings, and provides those who design welded buildings with the solution of their most pressing problem, namely, in what way should the floor beams of a building be joined to the upright columns. There are, of course, many possible ways but the designer must know which method is most economical consistent with accepted notions of safety. The method advocated by the Lehigh investigators involves the use of steel angles. A steel projection or angle is welded to each of two columns. The ends of the beam are then supported on the angles. Additional angles are welded to the top of the beam and to the column.

The Lehigh tests showed that the welded angle method provides rigidity under ordinary working conditions and at the same time sufficient flexibility to ensure that failure of the welded beam-column assembly under excessive load will not occur at the angle connections, but at the

*Mr. Lyse is professor at Lehigh University and Mr. Gibson was formerly American Welding Society Research Fellow.

center of the beam. Such an arrangement is the most economical because the full strength of the floor beam is utilized.

The tests upon which the method of design is based were made on full size floor beams, 8, 12, or 16 in. deep and 12 ft. long, welded to heavy structural steel columns. The angles were 3x3 in., and 5 to 7 in. long. The welding was performed with the aid of covered electrodes, which are steel rods, 18 in. long and from ⅛ to ¼ in. thick, covered with a layer of slag-forming materials.

The welded beam-column assembles were remarkably strong, the design theory developed by the investigators being amply substantiated by the experimental results. For instance, a welded connection designed to withstand a load of 17,200 lb. actually reached the limit of useful strength at a load of 36,000 lb. In another series of tests it was found that sustained and repeated loads had no unexpected deleterious effect on the behavior of the welded assemblies. The top-angle connection, as this type of assembly is called, may thus be used with perfect assurance in conjunction with the Lehigh methods of design in the welding of steel buildings.

The Heat Effect in Welding

By W. H. BRUCKNER*

It is occasion for marvel that there are readers enough for all that is printed. The average reader is able to scan an insignificant fraction of the printer's output. Every branch of human endeavor and interest has a staggering amount of literature, which is multiplying faster and faster. For this reason the Engineering Foundation is setting to work to summarize all that has ever been printed on the important phases of welding. The paper by W. H. Bruckner of The Naval Research Laboratory is a contribution to the program.

Mr. Bruckner has sifted through a large number of scientific articles written in French, German, and Italian, as well as in English, on one of the most perplexing problems in welding, namely: what are the effects of the welding heat on the metal being welded. The most obvious effect is that the temperature of the metal near the weld is raised. As the source of welding heat passes along, the temperature at any point near the weld first rises; then as the arc retreats, the temperature falls. The nearer the zone in question to the weld, the higher is its temperature. For different purposes it may be desired to spread out the heated zone or to restrict it as much as possible. In arc welding the heat affected zone is directly related to the electric power of the arc.

The heat affected zone constitutes metal heated to all temperatures up to the melting point. In steel the peculiar heat effects of welding give rise to hardened or softened zones, depending on the steel and the welding process. To avoid or remedy these heat effects the welder may change the type of steel he is using, or he may raise the temperature of the entire part to 200 to 1000 deg. F., or he may subject the welded part to a complete heat treatment. Details of the heat effect and its remedies may be found in Mr. Bruckner's authoritative summary of welding literature gathered from all parts of the world.

*Naval Research Laboratory.

Static and Impact Tensile Properties

By O. H. HENRY*

Smash-ups, collisions, and other accidental applications of sudden loads to metals are known to be frequent causes of failure. Brittleness under these sudden or, as they are called, impact loads, is especially dangerous in sub-zero weather, as in aircraft. Professor O. H. Henry, of the Polytechnic Institute of Brooklyn, is among the very few in the country who are gathering fundamental laboratory information on the behavior of metals, particularly welded metals, when they are subjected to impact at low temperatures, down to -110 deg. F. His present report is a detailed comparison of the properties of welded and unwelded ordinary and stainless steels under impact.

Professor Henry subjects his specimens to the tensile impact test. In this test a polished cylindrical specimen about 3 in. long and ¼ in. thick is pulled in two by a sudden impact blow delivered by a heavy pendulum traveling at 10 miles per hour. In order to rupture a welded specimen while it is at a specified low temperature, the specimen is cooled in a bath of ether and alcohol to which is added a few chunks of dry ice, which is frozen carbon dioxide.

The specimens tested by Professor Henry were of ordinary steel and of stainless steel containing 18 per cent chromium, 8 per cent nickel, known as "18-8." The ordinary steel was welded by three processes: electric resistance, atomic hydrogen, and bronze welding. Welds made by the first two processes behaved like unwelded steel in the tensile impact test. The bronze welds, which consisted of bars of steel joined together by copper-zinc alloy, not the usual copper-tin composition, had about the same impact and static tensile properties as unwelded bronze, because the bronze is weaker than steel. Although the tensile impact strength of all specimens tended to decrease slightly with temperature, there was no indication in Professor Henry's tests of the brittleness that is often associated with the fracture of steel at sub-zero temperatures.

The stainless steel welds, unlike the ordinary steel, maintained their impact tensile strength at low temperatures, but there was a slight decrease in ductility. These differences between the steels, as well as variations between the individual results constitute problems that remain.

In adition to his impact investigations at low temperatures, Professor Henry has also measured the strength of welds at low temperatures under slowly applied loads. A set of results on welds made by the oxy-acetylene torch gave convincing evidence of the relative advantages of different types of welding rods. A low-strength rod was definitely inferior to the "high-test" rod in these tests.

*Professor at Polytechnic Institute of Brooklyn.

Fatigue Tests of Butt Welds in Structural Members

By W. M. WILSON*

One of the greatest advances in recent times in structural engineering is the adoption of the fatigue strength in design. The time-honored testing method of determining the strength of steel for bridges and other structures by fracturing the steel under a continuously increasing load is now supplemented by determining the strength under repeated loads. The change in outlook between the static and the fatigue has been necessitated by the increasingly heavy loads carried by our engineering structures. These loads are always far below the fracture strength of the steel, but are always varying between a lowest and a highest value. Since a steel may fail under repeated loads that may be individually only 40

*Professor at University of Illinois

per cent of the static fracture strength, Professor Wilson's fatigue tests on welded structural steel, carried out at the University of Illinois, are of the highest importance, particularly because they are the only tests of the sort yet made in this country.

The tests were made on ordinary structural steel plates ¾ in. thick that were butt welded; that is, adjoining edges of two plates were welded together. The welds were 6 in. long and were made either by hand, with flux covered electrodes, or by means of the carbon arc process. The fatigue testing machine —the only one of its kind in this country—was capable of exerting loads of 200,000 lb. pull (tension), or push (compression). Professor Wilson varied the load on his specimens from zero to a maximum tension and calculated the fatigue strength from the test results, the fatigue strength being the load which would cause fracture on being repeated just two million times.

Professor Wilson found that the fatigue strength of a butt weld, as made by the welder, was 30 to 40 per cent of the static strength of unwelded steel, and only about 25 to 50 per cent less than the fatigue strength of unwelded steel. The fatigue strength of the weld could be improved up to 25 per cent by smoothing the weld flush with the plate, by heat treatment, or by hammering the weld metal while it is red hot. Actually none of the welded specimens was found to have a fatigue strength below 20,000 lbs. per sq. in. Professor Wilson's tests go a long way toward providing bridge designers and other structural engineers with the authoritative data on fatigue strength for which there is urgent need.

All-Welded Steel Tankers

By A. C. LEIGH*

The oil-carrying tank ship is a familiar sight in every large harbor. The forerunner of the "all-welded steel tanker" was the welded stationary oil storage tank. It was a natural development that the welded joint should be substituted for the riveted joint in tank construction, especially in oil tanks where tightness is paramount and where riveting in its most highly developed form often failed to give satisfactory and lasting results. The next logical step was the all-welded construction of the water-borne tank, the oil tanker being a composite union of a series of tanks.

Heretofore welding has been widely used in conjunction with riveting in shipbuilding, but the all-welded construction with no riveting is now becoming the order of the day, as A. C. Leigh of the Ingall Iron Works Co. pointed out. He described his experiences in the designing and welding of the first all-welded steel tanker, the motorship Transoil, 258 ft. long, 20,000 barrels capacity.

The economies of welding depend largely on the design. The designer should arrange that as much of the ship as possible, such as bulkheads, may be welded in the fabricating shop, where automatic welding is done under controlled conditions.

It is in the assembly of the prefabricated sections into the completed ship with shell plating that the shipbuilder's skill is called for. The method of assembly advocated by Mr. Leigh is very similar to the method now employed in the erection of the various portions of the plating and framing by progressive step. Using this method and taking advantage of the welding heat from the heavy coated arc welding electrodes to correct any mis-alignment that may develop, the tank shipbuilder is able easily to produce tankers possessing all the advantages and economies of welded construction.

*With The Ingalls Iron Works Co.

Building Up Locomotive Driving Boxes

By IRVING T. BENNETT*

"Building up" is a term that has been used by engineers ever since the introduction of welding. For weld metal may be deposited on a part wherever desired in order to build it up; that is, to increase the dimensions of the part. The building up process is being applied to the driving boxes of locomotives, as explained by Irving T. Bennett of Revere Copper & Brass, Inc.

The locomotive driving box has a metal lining which accommodates the large driving wheels during occasional misalignment, as in rounding a curve. In the past it was customary to cast bronze on the face of the driving box to produce the lining. These cast bronzes were a source of continual trouble, and welding is now used to produce a built-up lining of vastly superior wearing qualities.

The welder simply deposits as many layers of bronze as necessary on the iron driving box. The bronze is supplied by an electrode made of Herculoy containing 96 per cent copper, 3½ per cent silicon, ½ per cent tin. The electrode is ½ in. round and is covered with a fluxing material which protects the bronze from burning as it melts from the electrode on to the iron driving box under the influence of a welding current of 650 amp. The molten bronze alloys to some extent with the iron and, therefore, is firmly bonded. New boxes are lined in about 40 min.

The performance of the arc welded linings is judged by the interval between repairs. The old-style cast linings required renewal every 30,000 miles or so, whereas the built up linings have a life of up to 120,000 miles. Although the driving box lining is only one of a great number of locomotive parts, nearly $100 per locomotive is saved by the use of built up welded linings instead of the cast lining. The locomotive repair shop has demonstrated similar savings by the application of welding to many other locomotive parts.

*With Revere Copper & Brass, Inc.

Power Supply for Welding

By A. S. DOUGLASS and L. W. CLARK*

Although the welding industry is by no means the largest consumer of electric power, welding is a major and indispensable tool of many of the utilities largest customers. Colonel A. S. Douglass and L. W. Clark representing the Detroit Edison Company, who supply electric power to the large number of resistance welding machines used in automobile construction, outlined in their paper the numerous ways which the utilities are devising for giving more satisfactory service to the welding industry.

First let us glance at the amount of power used by the three main welding processes: arc, gas, and resistance. That heat for arc welding is provided by an electric arc struck from the welding electrode, a steel rod about ⅛ in. diameter and 14 in. long, to the parts to be welded together. Each pound of electrodes consumes 2½ kwh. and there were six and a half million pounds of electrodes welded in 1936. Although the welding heat in gas welding is supplied by burning gases, oygen and acetylene, electric power to the extent of seven million kwh. was used last year in manufacturing these gases. The power used by the large number of resistance welding

*Both of Detroit Edison Co., Detroit, Mich.

machines is estimated to be 40 million kwh. Summing up, a grand total of 63 million kwh. of electric power was used by welding in 1936.

The problems in distributing the electric power to welding are largely created by the resistance welding machines. These machines require enormously large gulps of power at intervals of only a tiny fraction of a second. Under ordinary circumstances such unusual power demands would strain the capacity of the utilities' mains and would cause flickering of lamps or momentary slowing down of electric motors throughout the district. The utilities have evolved a number of protective devices which to a great extent eliminate the disturbances caused by resistance welding machines. In protecting their own systems, the utilities at the same time provide more satisfactory service to the welding industry and to power customers in general.

Welding in Tanker Construction

By T. M. JACKSON*

Welding is being very extensively used in the construction of large oil tankers. Welding provides smooth surfaces which drain freely, are easily cleaned, and are less subject to corrosion than riveted construction. In addition, welding often results in substantial savings in weight. T. M. Jackson of the Sun Shipbuilding & Drydock Co. told of his experience in welding the midship portions of nine tank ships.

Three of these ships were 542 ft. long, 18,500 tons, in which the entire cargo tank space extending from the engine room to the forward end of the tank space, a length of 353 ft. was of 100 per cent welded construction. The scheme is to weld as many parts of the vessel as possible in automatic welding machines under the most favorable conditions. In this way, all the bulkheads are pre-fabricated before fitting them on the keel, which is laid in the usual way.

The automatic welding process favored by Mr. Jackson is the Unionmelt process. In this process the heat of welding is supplied by the electric resistance of a layer of fused mineral compounds on much the same principle as is involved in an electric heating radiator. The Unionmelt process deposits an entire weld in a single layer and provides the solution of many problems of distortion. Butt welding is adopted for all the main structure, lap welding being employed only for relatively unimportant connections.

In welding the main units both automatic machine welding and manual arc welding are employed, the former only for shop assemblies. The manual arc is used on shop assemblies where the use of the automatic machine is out of the question. All welding on the shipways in connecting the assembled sections is also done by hand. The change-over from riveting to welding in a shipyard leads to a somewhat different shop layout and particularly to a somewhat different personnel. Welding is not a strenuous operation; it requires skill rather than brawn.

*With Sun Shipbuilding & Dry Dock Co.

Stainless Steel as Applied to Pressure Vessels

By J. C. HOLMBERG*

Nowadays if a material is badly needed, it is not long before someone develops or invents it. Nor is it long before the new material becomes a tonnage product. Such has been the case with stainless steels, the well-known steels containing 12 to 25 per cent chromium with or without up to 10 per cent nickel. As pointed out by J. C. Holmberg of the Struthers Wells-Titusville Corp. in a symposium on the welding of high alloy steels, none of the stainless steels was known at the opening of the twentieth century and many had not been conceived as early as fifteen years ago.

Fortunately, welding had been growing and becoming a popular means of fabricating during this same period. It is not surprising that this method of making joints was rapidly adopted for many successful installations which could never have been built by other methods. Especially is this true in the food, rayon, and other chemical industries in which tanks, mixers, towers, pots, and other equipment must be resistant to corrosion, proof against leaks, and free from crevices where food or other products may lodge and ferment.

Of the many examples of welded stainless steel products cited by Mr. Holmberg perhaps the most interesting is the combination rail and truck milk tank. The inside of the tank is stainless steel which is covered first with heat insulation and then with sheets of mild steel. The interior must take a sanitary polish, including the welds in which depressions or pores are inadmissible.

Another instance is a welded stainless steel vulcanizer for motor car steering wheels. Made of 18-8 (18 per cent chromium, 8 per cent nickel) ½ in. thick and 50 in. diameter, 18 ft. long, the vulcanizer cost $10,000, whereas the same apparatus made of mild steel would have cost only $2,000. The product from the stainless vulcanizer, however, is not rust stained as would be the case with a vulcanizer made of ordinary steel.

A most unusual application of welded stainless steel described by Mr. Holmberg is an X-ray machine for the treatment of cancer built for Columbia University and the Presbyterian Hospital, New York. Stainless was selected because its greater density assures successful operation of this high-vacuum apparatus.

Other applications of welded stainless have been made in the paper and textile industries, and the interesting material: nickel-clad mild steel also is being used to an increasing extent in welded containers of all sorts and sizes. All told, the welded stainless steel presmind when confronted with probsure vessel is something to keep in lems of severe corrosion.

*With Struthers-Wells-Titusville Corp.

Tests and Arc Welding in Ship Structures

By LIEUT. COMMANDER W. P. ROOP*

In introducing his paper before the Annual Meeting of the American Welding Society, Commander W. P. Roop of the U. S. Navy stated that the Eskimo Kayak, a remarkable perfection in hull design, was developed without the aid of laboratories. He then goes on to state that although essentially the same composite construction is used in Navy vessels as in Kayaks, the materials, methods, and dimensions of the latter cannot be compared with the former. The modern welded vessel requires the aid of a laboratory in its construction.

Aside from its purpose as a source of new methods, the laboratory is to a large extent in control of tests. It should never be forgotten, said Commander Roop, that the ultimate object is to produce *satisfactory welded structures.* "What we want is a joint that will behave in service as if there were no joint." The tests made to determine whether the welded joint possesses this quality are of two kinds: 1. the direct test in which the conditions of service

*United States Navy.

must be known accurately; 2. the indirect test in which test conditions should duplicate service conditions as closely as possible.

Commander Roop directed his fire particularly against tests of either kind which are not decisive. For example, he stated, "It has become a truism that weld value depends on personal qualities in the welder. A personal qualification test is easily devised, but demonstrates only that a man *can* make a satisfactory weld, not that he *does* so." Wherever possible the drift of practice is away from dependence on personal skill of the individual welder and toward fuller control of process and technique.

Here Commander Roop raised the question: What is the best technique? "No subject in welding is subject to wider differences of opinion, which demonstrates that tests of welding technique are not conclusive. The direct test doesn't work well for the reason that equally good welds can be made by different techniques, and besides there is yet no convenient method for defining the techniques now in use.

Concluding his stimulating and provocative appraisal of present day methods of testing everything connected with welding, Commander Roop expressed the belief that we must now provide ourselves with harmless accidents. In learning how to explain them we shall also learn how to avoid them.

Assembly Plant for Welding of Barges

By GEORGE F. WOLFE*

Often the humble barge has been the proving ground of the shipbuilding industry. The severe punishment to which barges are subjected is notorious. For this reason and on account of their insignificance, barges are usually the first type of vessel in which new developments in ship design and construction are given a trial. If the new principle succeeds in the barge there is hope for it in larger vessels.

One of the most far reaching of the new developments in shipbuilding is the adoption of the assembly line method, as described by Mr. Wolfe of the Dravo Corporation. The assembly line method with completely housed operation for barge building was evolved as the result of a study of production methods in other industries. As a result there is no congestion of equipment on the launching ways.

In brief, the method of building a welded barge consists of fabricating the elements of the barge in as large pieces as can be handled conveniently. The sides of the barge are box sections 30 ft. long, 10 ft. deep, 3 ft. wide, weighing 10 tons each. These are fitted to the bottom on a special fitting table which may be tilted to facilitate the welder's work.

Upon assembly of all side sections to the bottom, the barge, which, if it is of the coal hopper type, may be 175 ft. long, 26 ft. wide, and 11 ft. deep, is ready for launching. The entire barge is placed on a massive transfer carriage equipped with four 14 ton hydraulic jacks which carries it to the launching ways. The barge is launched sideways into the river with the customary splash and comes to rest ready for immediate service.

Welding Low Alloy Steels

By DR. A. B. KINZEL*

In his opening remarks at the Symposium on Welding Low Alloy Steels, Dr. A. B. Kinzel of the Union Carbide and Carbon Research Corporation stated that the welding of low-alloy steels today is an accepted practise. The low alloy steels are steels in which ½ to 4 per cent of alloying element, such as chromium, copper, or nickel, is added. The added elements raise the strength and hardness of steel without sacrificing ductility or toughness.

The major problem in welding the low alloy steels is to obtain a joint that is tough under shock as well as under quiet load. Under some conditions a zone adjacent to the weld may be obtained that is considerably harder than welded steel. In unalloyed steel an increase in hardness is accompanied by a loss in toughness. The low alloy steels, however, remain tough despite a similar increase in hardness. In this fact lies their usefulness.

The problems that, in the past, have beset the welder of low alloy steels have practically disappeared. Strength and soundness are merely a question of choice of welding rods and methods. It used to be thought that more trouble with shrinkage would be encountered with low-alloy than with unalloyed steel. It is a fact, nevertheless, that the low-alloy steel, since its high strength permits the use of thinner plates, involves the welder in no shrinkage problems not encountered in unalloyed steel.

Summarizing the current industrial situation, Dr. Kinzel classes as foolproof those steels containing less than 0.15 per cent carbon and having a strength below 80,000 lbs. p.s.i., providing the thickness is not excessive. Steels containing a higher percentage of carbon, but not exceeding 95,000 lbs. p.s.i., in strength likewise may be used with complete satisfaction if the welds are relieved of shrinkage stress by suitable heat treatment. All in all, the welding of low-alloy steels is only a very small step beyond the welding of unalloyed steel; welding can be adapted to these steels in much the same manner and to the same degree.

Wrinkle Bending for Field Fabrication of Pipe Bends

By R. B. AITCHISON*

As civilization progressed some commodities, such as water, came to be used in such large quantities that the system of distribution by the barrel or tank load became economically unsound. The system of distribution by pipes radiating from a central source of supply replaced the laborious batch distribution system for water, gas, and more recently oil. The systems for oil, (particularly from the wells in Texas to refineries on the Great Lakes and the Atlantic Seaboard), and natural gas, are particularly important and comprise many thousand miles of pipe. Practically all the joints in these steel pipes are welded.

The natural gas pipe lines are laid in shallow trenches and take the shortest distance from pump to pump. Nevertheless the pipes are not straight but must be bent to the shape of the mountains and gulleys they cross. A novel method for making the bends was described by R. B. Aitchison of the Linde Air Products Company. This method is known as wrinkle bending, and replaces the extremely laborious system of cold bending which has been used hitherto.

To wrinkle bend a pipe, an oxy-acetylene torch is used to heat a narrow band bright red at right angles to the pipe and extending half way around the pipe. The pipe is then bent either by hand or by means of a tractor. In this way the heated section is slightly buckled, and the bend is smooth and sweeping. For bends of greater curvature two or more wrinkles are made. The wrinkles project outwards, thus providing a full opening throughout the

*Dravo Corporation, Pittsburgh, Pa.

*Union Carbide and Carbon Research Corporation.

*The Linde Air Products Co.

bend. A wrinkle may be made in 2½ to 3 min.

Wrinkle bending lends itself readily to correction, since too much bending in one or more wrinkles may be taken out simply by reheating and reversing the pull or sag. Furthermore the pipe is not stressed as in cold bending because the bend occurs only where the pipe has been softened by heating. One of the most important advantages of wrinkle bending is its low cost.

Welded Girders With Inclined Stiffeners

By CYRIL D. JENSEN and WILLIAM F. LOTZ, JR.*

Modern steel construction is based on the use of girders. These are simply beams that are too large to be rolled economically in one piece at the steel mill and are, therefore, welded together from three separate flat plates: the web plate and two flange plates. In order to prevent the buckling under load of the largest of these three plates, which may in extreme cases, be as much as 10 ft. high, the steel constructor is forced to stiffen it by welding stiffeners to it. In this form the stiffened girder is used in the construction of buildings, mills, cranes, ships, bridges, subways, and, in fact, all heavy engineering structures.

From time immemorial the stiffeners have been welded to the web straight up and down between the flanges of the girder. The acceptance of the vertical stiffener by the structural designer apparently has been based on nothing more sound than tradition, and the tradition is now under attack by Professor Cyril D. Jensen, of Lehigh University, and one of his students, William F. Lotz, Jr.

Professor Jensen found first of all that the vertical stiffeners in actual fact supported an insignificant proportion of the total load on the stiffened girder. It occurred to him that the stiffeners might be made more effective by inclining them to the vertical. Adopting the system familiar to research workers in all branches of science and engineering, Professor Jensen tried out his new "medicine" on models. In this instance, the models were of cardboard and of transparent celluloid.

Both models having demonstrated the vast superiority of the inclined over the vertical stiffener, Professor Jensen and his student collaborator decided that the time had arrived for a test on full-size welded steel girders with both systems of stiffening. True to expectations, the welded girder with inclined stiffeners withstood approximately 20 per cent higher loads without buckling than the girder with vertical stiffeners. Besides, the inclined stiffener carried a considerable proportion of the load on the girder.

New developments in methods of steel construction are not slow to be adopted by engineers. Professor Jensen's tests unquestionably suggest a new development: namely, the use of inclined in place of vertical stiffeners. Although a good deal remains to be worked out, especially in connection with the most advantageous angle of inclination of the inclined stiffeners, the attention of the structural designer has been seriously directed toward the results of the Lehigh tests.

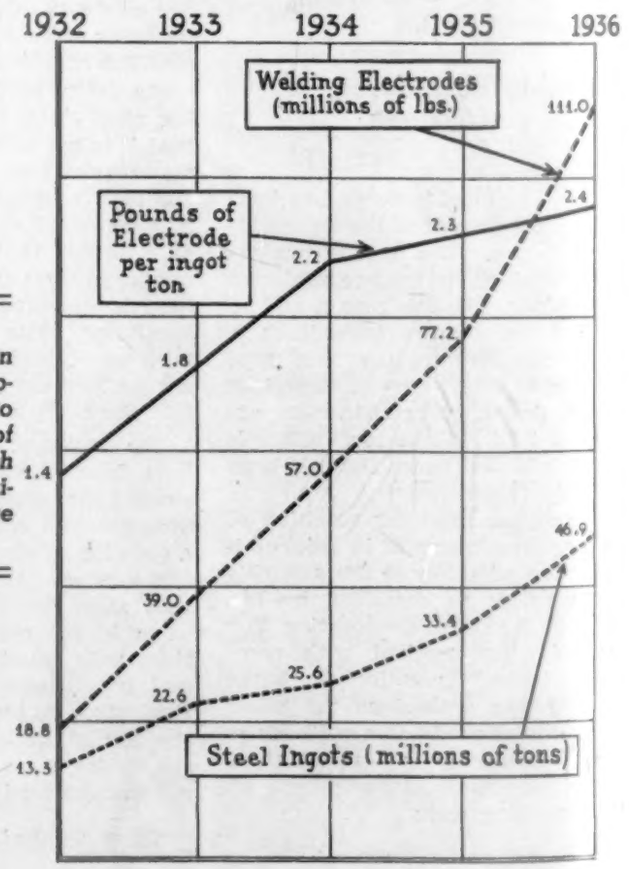
*Mr. Jensen is a professor at Lehigh University and Mr. Lotz, Jr., is a student.

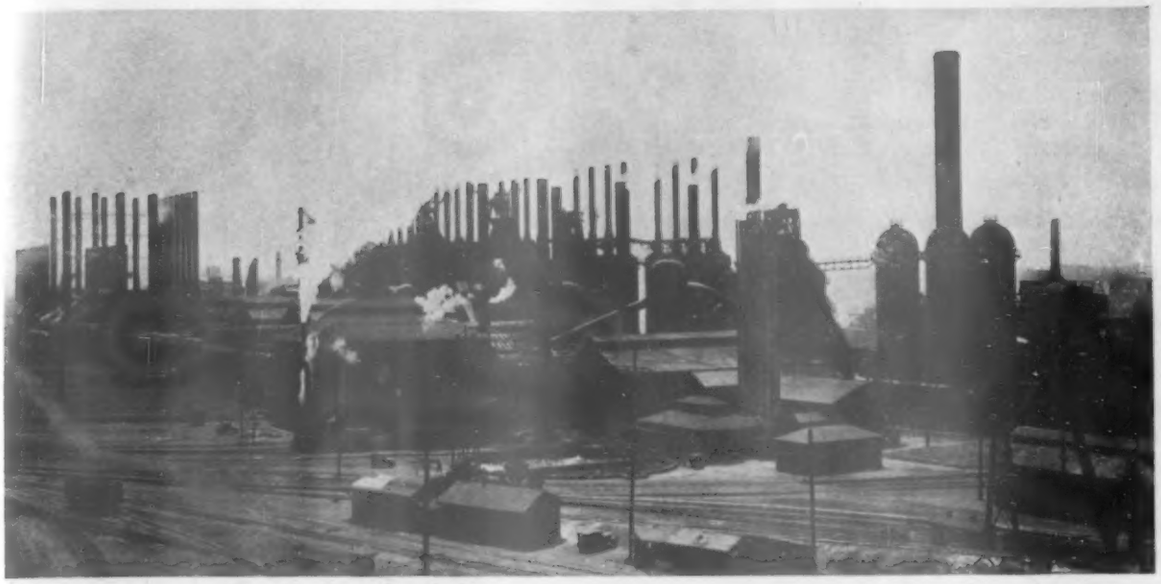
Arc Welding Moves Ahead

True to the predictions that were made for it a decade ago, the electric arc welding process has been making big strides in extending its fields of usefulness according to the National Electrical Manufacturer's Association. The growth in volume in the past five years is shown by the N.E.M.A. reports of electric welding wire consumption, from 18.8 millions of pounds in 1932 to 111 millions of pounds in 1936. It is thought in some quarters that there will be recorded a further 50 per cent increase when the total for 1937 is known. That this progress is not all due to the general revival of industrial activity is shown by the steady increase in volume by comparison with the early thirties, before any real industrial revival had started. A more graphic proof is the increasing amount of electrodes being used for each ingot ton.

In 1932 the figure was 1.4 lbs. of electrode for each ingot ton; in 1936 this figure had reached 2.4 pounds, an increase of 17 per cent. 1937 activities indicate that the trend is still definitely upward. In general, this growth may be ascribed to the fact that the shielded arc process makes possible a quality of weld deposit that has won engineering acceptance in nearly all the major fields of steel construction and fabrication. Prominent naval engineers have stated that the riveted ship is on the way out, barge and tanker construction for inland waterways is largely an all-weld job, and railroad freight cars are being welded in large quantities.

Steady growth in electrode consumption due largely to better quality of weld deposit which has won wide engineering acceptance





A battery of blast furnaces at mill of Tennessee Coal, Iron and Railroad Co.

38th Annual Meeting of I. A. A. Will Feature Recent Advances

Of interest to welding engineers and operating men — Three-day convention in Birmingham will draw many from the South

OUTSTANDING leaders in the welding industry are to appear on the program of the 38th Annual Convention of the International Acetylene Association according to an announcement just issued by the secretary. The meeting is to be held in Birmingham on November 10, 11 and 12, at the Tutwiler Hotel. The program includes meetings which will be of interest to everyone in the welding industry and to all who use welding or cutting. Three technical sessions are to be held in the afternoons. Round table discussion groups, so popular last year, are scheduled for Wednesday and Thursday evenings. The tentative program for the convention follows:

WEDNESDAY, NOVEMBER 10

12:15 P. M.

Opening Session

Features will be the opening address by C. D'W. Gibson, President of International Acetylene Association, and the presentation of the Morehead Medal.

2:30 P. M.

First Technical Session "Speeding Manufacture and Construction With Oxy-Acetylene Welding"

CHAIRMAN: Lester N. Shannon, Vice-President, Stockham Pipe and Fittings Co.

Papers to be presented are as follows:

"Butt-Welding of Railroad Rails"
R. R. Cummins, Central of Georgia Railway, Atlanta, Ga.

"Piping Design, Fabrication and Erection"
O. B. McLaughlin, Freeport Sulphur Co., Port Sulphur, La.

"Welding of Power Piping"
Lee Hopkins, John W. Danforth Co., Buffalo, N. Y.

"Metallurgical Problems in Bronze-Welding Cast Iron Pipe"
Dr. J. T. MacKenzie, American Cast Iron Pipe Co., Birmingham, Ala.

"Welding of Cast Iron Pipe"
C. L. Lane, Walworth Alabama Co., Birmingham, Ala.

"Welding In A Chemical Plant"
E. A. O'Neal, Monsanto Chemical Company of Alabama, Anniston, Ala.

8:15 P. M.

Round Table Discussion—Engineering Session

A series of concurrent meetings for open discussion of problems of economics, management and design, related to welding and cutting—of special interest to managers, engineers, foremen and others planning and supervising welding and cutting operations.

GENERAL CHAIRMAN: J. I. Banash, Consulting Engineer, International Acetylene Association; Past-President, National Safety Council, Chicago.

Subjects to be discussed are:

Codes and Operator Training

Stainless and Alloy Steels

Aluminum, Nickel, Copper, and Other Non-Ferrous Metals

Hard-Facing

Pipe Welding

Cutting and Use of the Oxygen Lance

Fire Prevention and Safety

THURSDAY, NOVEMBER 11

12:15 P. M.

Annual Luncheon and Business Meeting

Reports of Committees
Election of Officers

Chairman: C.D'W. Gibson, President, International Acetylene Association

2:30 P. M.

Second Technical Session "How and Why to Use Oxy-Acetylene Cutting"

CHAIRMAN: E. E. Michaels, Chairman, Birmingham Section, American Welding Society; General Manager, Chicago Bridge and Iron Company, Birmingham, Ala.

Papers to be presented are as follows:

"Oxy-Acetylene Cutting in Fabrication"
A. E. Gibson, President, American Welding Society; President, Wellman Engineering Company, Cleveland

"Management of Machine Cutting Operations"
Dr. G. V. Slottman, Air Reduction Sales Co., New York

"Cutting and Tempering of Structural Steels"
H. H. Moss, The Linde Air Products Company, New York

"Use of Shape-Cut Parts in Machine Design"
Lukens Steel Company, Coatesville, Pa.

"Cutting Alloy and Clad Steels"
W. D. Keelor, Ingersoll Steel & Disc Division, Borg-Warner Corp., Chicago

"Oxy-Acetylene Cutting As Applied to Repair and Conversion of Present Cargo Vessels to Tankers, and to Marine Work"
A. C. Leigh, Ingalls Iron Works Company, Birmingham, Ala.

C.D.W. GIBSON—President
International Acetylene Association

8:00 P. M.

Round Table Discussion—Operating Session

A series of concurrent meetings for open discussion of practical problems of welding and cutting—of special interest to shop owners, welding and cutting operators as well as to those planning and managing welding and cutting operations.

GENERAL CHAIRMAN: Warner S. Hays, Managing Director, American Welding Society

Subjects to be discussed are:

Hard-Facing

Cutting and Use of the Oxygen Lance

Aluminum, Nickel, Copper and Other Non-Ferrous Alloys

Pipe Welding

Bronze Welding

Low Temperature Brazing and Use of the Air-Acetylene Flame

Sheet Metal and Steel Plate Welding

Stainless and Alloy Steels

FRIDAY, NOVEMBER 12

8:30 A. M.

Plant Inspection Trip—Tennessee Coal, Iron and Railroad Co., Ensley and Fairfield, Ala.

An interesting and informative tour of a complete iron and steel plant.

2:30 P. M.

Third Technical Session "Maintenance and Operating Uses of the Oxy-Acetylene Process"

CHAIRMAN: K. L. Landgrebe, Vice-President, Tennessee Coal, Iron and Railroad Co., Birmingham, Ala.

Papers to be presented are as follows:

"Selective Hardening of Ferrous Materials With the Oxy-Acetylene Flame"
R. L. Rolf, Lakeside Steel Improvement Co., Cleveland, O.

"Flame Hardening"
John Howatt, American Spiral Spring Co., Pittsburgh, Pa.

"Important Uses of the Oxy-Acetylene Process in Steel Mill Operations"
W. J. Sannemann, Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.

"Reclamation of Textile Mill Parts"
Hugh Comer, Avondale Mills, Sylacauga, Ala.

"Welding Stainless and Alloy Steels"
H. C. Whittmer, Republic Steel Corp., Cleveland, O.

The round table discussions will be held in the auditorium of the Phillips High School. At a similar session held at the convention in St. Louis last year, over 2,000 attended. Because of the interest shown in these meetings last year, two evenings are devoted to these discussions. Each group meeting will be in charge of a group chairman who will be assisted by guest technical advisors. These will be recognized authorities on the subjects under discussion.

Among the advisers to be present at the round table discussions are:

W. D. HALSEY, Hartford Steam Boiler Inspection and Insurance Company.

H. L. WHITTEMORE, U. S. Bureau of Standards.

A. E. GIBSON, Wellman Engineering Company.

DR. G. V. SLOTTMAN, Air Reduction Company.

DR. A. B. KINZEL, Union Carbide and Carbon Research Laboratories, Inc.

H. C. WHITTMER, Republic Steel Corporation.

W. B. KEELOR, Ingersoll Steel and Disc Div., Borg-Warner Corp.

I. T. HOOK, American Brass Company.

F. G. FLOCKE, International Nickel Company.

J. R. DAWSON, Union Carbide and Carbon Research Laboratories, Inc.

GEO. HOGLUND, Aluminum Company of America.

PROF. O. M. HARRELSON, Georgia School of Technology.

W. A. WISSLER, Haynes Stellite Company.

LEO HURST, Georgia Natural Gas Co.

J. T. HARDWICK, Tennessee Coal, Iron and Railroad Co.

R. F. HELMKAMP, Air Reduction Company.

A. J. BELDON, The Linde Air Products Company.

H. E. WINKLEMAN, National Cylinder Gas Company.

J. J. CROWE, Air Reduction Company.

E. M. EVLETH, Bastian-Blessing Company.

EVERETT CHAPMAN, Lukenweld, Inc.

J. I. BANASH, National Safety Council.

H. F. REINHARD, Secretary, International Acetylene Association.

E. J. SMITH, Underwriters' Laboratories, Inc.

H. S. SMITH, The Prest-O-Lite Company, Inc.

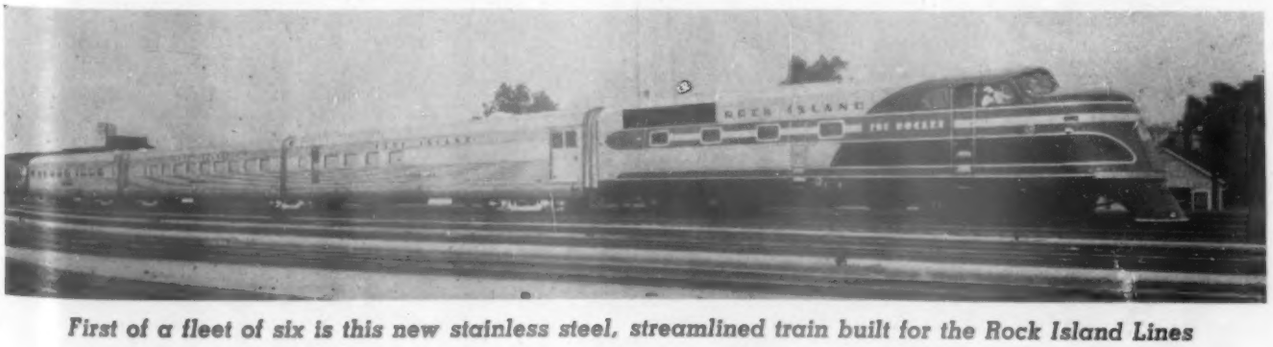
Copies of the complete program can be obtained upon request to the secretary at the office of the Association, at 30 East 42nd St., New York City.

Rock Island Has Six New Streamlined Trains

Six new Diesel-powered "Rockets" will soon be placed in regular passenger service on the Rock Island Lines. A feature of these new streamlined speedsters is the welded stainless steel coach construction, weighing only half as much as coaches of conventional design. The cars were built by Edward G. Budd Mfg. Co., Philadelphia, using the Budd "Shotweld" process of welding. Each power unit has a 1200 hp. Diesel engine built by Electro-Motive Corp., McCook, Ill.

The average speed of these trains when placed on regular schedule, according to Rock Island officials, will be about 70 miles per hour. This will reduce the running time of the present service, in some instances, by about two hours. All are daylight trains, air-conditioned throughout, with the most modern facilities and striking interior color decorations.

The first car in the three-car trains contains a baggage compartment, behind which is the kitchen, connected with a dinette compartment seating 32 persons. The second car has reclining chairs, seating 74 persons. The third car is the observation-parlor car, seating 48 persons. This car is equiped with a counter or bar for serving refreshments. In the four car trains another coach is included.



First of a fleet of six is this new stainless steel, streamlined train built for the Rock Island Lines

The Story of Acetylene

Man's constant struggle upward is told by his efforts to obtain better artificial light—Calcium carbide has played an important part in the evolution of modern lighting

By W. F. KUHL

District Manager, Shawinigan Products Corp., New York

THE emancipation of the human race from the slavery in which primitive man was born to spend countless centuries, totally subservient to nature's whim, dates from the discovery of fire, and consequently artificial light. Hendrik Van Loon, in his book, "The Story of Inventions," begins his narrative with the following paragraph—"One fine day a small speck of dust (it weighed only six thousand decillion tons, which is very little as such luminaries go) wandered forth from its ancient mother, the Sun, and set up in business for itself."

To appreciate, even in part, the importance of artificial lighting in the advancement of the human race, it is necessary to know something of the problems confronting prehistoric man in his struggle to live and eventually emerge into that period which we are pleased to term civilization.

When this tiny globe of ours set up in business for itself, it is reasonably certain from what we already know, that most of its surface was covered with water, and what little land was not covered with slime and mud—was heavily wooded and dense with rank vegetation. Life itself, in all probability, was largely dominated by fierce, indescribable creatures of the air; the sabre-toothed tiger, the mastodons, dinosaurs, and all sorts of ferocious beasts in the forests; and for the rest a multitude of slimy crawling things ranging from the lizard to gigantic monstrosities existing only by virtue of their ability to withstand the intense cold and heat; the foulness incident to life spent in low marshy areas with its semi-poisonous atmosphere, and last but not least the never-ending strife and murderous battles constantly waged one against another.

Early Man's Insecurity

In such surroundings man, in the stage of evolution, first saw the light of day. Beset on every side by savage beasts battling for existence—never knowing what minute might be his last, never daring to venture forth at night; never safe in whatever hole or crevice he might crawl into with the setting of the sun—more often than not he ceased to live in order to provide a meal for some other living thing.

Thus, we see man at that date, very little removed from the other savage beings about him—existing on precisely the same plane, forced to kill constantly in order that he might live, or suffer himself to be killed as the alternative. Under this continued pressure, and being at a disadvantage in size and strength, his latent cunning was more and more brought into play, and slowly but surely his brain began to function. The never ending battle in which he was required to match his wit against the heavier and more clumsy effort of his opponents, began the development of this brain which ultimately led to that state of intelligence where he became the master of all other living animals. The progress of this function of thought on his part appears to have been very slow and gradual.

The Struggle for Existence

In the beginning, we assume, man lived as the beasts which surrounded him—naked and protected from the elements only by his own hide; finding his rest wherever he happened to be, or where circumstances would permit. Possibly his awakening intelligence led him into the shelter of a rock or cave, the possession of which was usually disputed by something more blood-thirsty and ferocious than himself. Then after countless years and through accident, he discovered that he could protect himself from the cold and rain by wrapping himself in the skin of some animal which he had killed for his supper. That, in itself was a tremendous step forward—and, we might add, the foundation of the clothing industry.

As the world emerged from various glacial periods and the consequent floods receded, the land areas increased, providing greater spaces better adapted for man's particular needs. The gradual climatic changes also produced a temperature more

suitable to his development. Thus nature herself, coupled with occasional accidental discoveries, accounted for the first slight easing of the hard lot of the human species!

Now comes the most important discovery of all time—Fire. Probably through some such accident as a lightning flash; the eruption of a volcano, spontaneous combustion, or a rock slide causing a spark to ignite some inflammable material, fire was born. The poor savage, together with his animal neighbors, undoubtedly observed this strange new phenomena in trembling fear. After the first fearsome reaction came curiosity regarding this thing that could produce light and heat which until then had only come from the sun. Overcoming his terror, he managed to salvage a flaming stick which he carried to his cave. Man had advanced another step on his road to civilization, and the fire on the ledge at the opening to his cave, became the first symbol of "Home Sweet Home."

The First Home

A crude pitiful hovel—this first cave home—but nevertheless a home. By the use of fire it could be warmed and protected from savage predatory animals who heretofore had contested for the possession of such shelter.

Then too, the home could be lighted by means of the fire, or if the heat became too oppressive, a burning stick could be placed in a crevice or on a flat stone with another stone on top to hold it in position. And so was born the first artificial light. No longer was man limited to the sun for his heat and light. The restraining shackles of limited hours in which to accomplish his daily tasks had been thrown off forever, to say nothing of the protection from living terrors of the dark hours.

Now, having made the discovery of fire, prehistoric man learned that unless constant care was exercised the flame would disappear, and when it did he was forced to await another accidental happening to again obtain a flaming stick or a glowing ember. We may be sure that steps were taken to keep this life-conserving and consuming thing alive after the first few experiences!

Eventually through another accident he found that by rubbing two sticks together long enough and hard enough they became heated and finally smoldered into a flame. That was in reality the first match. Another advance and another milestone from slavery. This discovery was made countless centuries ago, for when we turn back the pages to the very beginning of our historical records, we find this art of fire-making was already well known.

During the "stone age" when folks began making things from stone, they found that two stones struck sharply against each other would produce a spark that could be utilized with the aid of a bit of inflammable material, to create a fire. Much, much better than accidents! And this discovery led to the tinder box—a bit of fire-stone and a piece of metal, with some dried grass or peat moss! This invention had considerable merit, for it is the granddaddy of our modern cigarette-lighter!

Following the tinder-box, some time in the 17th century, we become familiar with the scraps of wood impregnated with sulphur which were ignited by means of hitting small lumps of phosphorous with a stone. Because of the danger incident to their use and the poison contained in yellow or white phosphorous, plus the expense, they were more or less a passing fancy. In the early part of the 18th century there appeared a cumbersome sort of friction match. It was not until about the middle of that century that the match, similar to those in use at the present day, was perfected.

Another means of creating fire was discovered—the use of glass to focus the sun's rays. Under clear atmospheric conditions and with a high sun, it is also possible to kindle a fire with the aid of a piece of ice fashioned in the shape of a convex lens.

The Burning Stick

It is difficult to name in proper sequence the various types of lights and lamps as they were developed from prehistoric days to the present, so wide and varied have been their shapes and forms, as have been the materials and fuels utilized. First, the burning stick or fagot was probably the earliest means of artificial illumination, aside from the open fire itself. Then came the wood splinters sliced from a resinous tree or from wood that had been impregnated with a fatty grease or oil. which were used in conjunction with the splinter holder. Rushes prepared with grease were also used in place of wood splinters in these holders. Resinous gums wrapped in leaves; animal carcasses; certain kinds of fish which were stuck in a cleft stick; and birds have all served as means for providing light in various parts of the globe. So keen and desperate has been the desire for light that even the glow-worm (larva of the fire-fly) was forced into use! It is definitely known that quantities of fire-flies imprisoned in perforated gourds, or in vessels of clay with holes punched in the sides have been utilized in the early stages. Our first lantern, by the way!

Some of the earliest types of lamps using animal or vegetable fats, have been first the human skull itself; skulls of small animals; flat stones with the center hollowed out and then a more elaborate stone lamp appeared during the stone age. These were superseded by clay and terra-cotta molded in numerous shapes and sizes. After that came the metal age with its manifold possibilities for shaping and forming, opening the field for the ancient fire baskets; these to be followed by the artistic creations from glass. Large stone and clay vases have had their day too. A unique contrivance resembling a small mill which produced a stream of sparks through the striking of a metal wheel on flint was at one time used by the miners when employed underground.

Dried Fish Skins

Amadou—a soft spongy substance from fungi growing on trees and used as tinder was another means of crude illumination adapted by the miner as well as fireflies in a bottle—dried fish skins, from the scales of which a faint phosphorescent light was given—candles and torches.

A system of mirrors for mine lighting was also tried. A large mirror at the top of the shaft reflected sunlight to the bottom where another glass threw the light into the drift. It worked after a fashion but could only be used in shallow mines and as the rays could be reflected but a short distance into the drift tunnel, was most unsatisfactory.

Where open flames could not be used in "gaseous" mines another means of illumination had to be found and the "safety" lamps such as the Clanny, The Dayy, Scotch Davy, Davy in a Can, Stephenson, Wolf, Koehler and Ceag Lamps were inventions that did much to overcome this difficulty. These lamps were constructed so that the flame was enclosed by glass and a wire gauze. The theory being that gas outside of the lamp itself could not be ignited by the flame. The fuels in these lamps ranged from the candle to various types of oil.

It is interesting to note the construction of an early type Clanny

lamp. Water was placed in the bottom, a candle partly submerged and held in place by a holder on the lower plate provided the fuel. Another layer of water was arranged above the flame and the air necessary for combustion was forced through the lower water level by means of a hand bellows. The combustion elements escaping through the upper water seal.

Probably the very first fuel for lamps was grease, or the crude fat from animals; followed by vegetable oils obtained from a variety of nuts, olives, plants and vegetable matter; including resinous substances extracted from wood.

Mammals Were Slaughtered

As the demand increased, man turned his efforts into profit by hunting amphibious animals such as the walrus, seal, etc., and untold numbers of huge mammals of the seas were slaughtered to provide a steady stream of fats and oils. Sperm oil, obtained from the head cavities of sperm-whale, was one of the better known of the animal oils. The cultivation of vegetable sources was also undertaken and Colza oil, extracted from rape-seed, had a relatively wide market. Mineral oil came into general use about 1853-1855, when the modern lamps began to appear. During this period, gas also made its appearance as a most important means for lighting.

Running through this "light picture of the ages" we must not forget the candle which in one form or another has a long history of its own. After the wood splinter, the tallow dip may possibly have been the first step towards candle making, followed by the tallow candle and those made from bees-wax. The first wax candle was more expensive than those made from tallow, and was to be found only in the homes of the rich until approximately the 15th century. A white waxy substance obtained from the head of the sperm-whale, known as Spermaceti, has also been used in candle making.

The Candlemaker's Art

In later years, tallow has been used principally to manufacture Stearine, and this is mixed with paraffin wax, derived from petroleum, to make the modern inexpensive candle. Stearine and a sort of wax obtained from cocoanut oil is another combination of the candlemakers art. The actual method of manufacture in common use is molding, pouring, drawing and dipping.

With the advent of the manufactured illuminating gases and the use of electricity for artificial lighting, when man demanded more conveniences as a requirement of the daily need in his advanced standards of comfort and living, we came into an entirely new era, wherein acetylene gas from calcium carbide assumes an important role on land and sea.

Probably the most outstanding single phase in the development of acetylene lighting occurred with the invention of the bicycle lamp about 1901-1902. Previous to that time the horse-drawn vehicles of the day were dependent, when lights were used at all, on the oil consuming, and the "buggy" type lantern—usually a square box-shaped affair having two (and sometimes three) of its sides enclosed with heavy glass and in which a candle was burned. The lighting range of this new carbide lamp was far superior to anything theretofore available for vehicular traffic.

The Miner's Cap Lamp

The wide use of these bicycle lamps emphasized the possibilities of acetylene lighting in many other fields and opened the way for improved and more elaborate devices using carbide as the fuel. The Miner's cap lamp used so universally by mining men at the present time is a direct descendant of the bicycle lamp and appeared on the market about 1904. About the same time, the automobile was becoming more popular, being produced in increasing numbers and for a time they too, were practically entirely dependent on acetylene gas for light when driving at night.

Then came the carbide lantern used by railroad yardmen and section crews. Flare lights were another important contribution, being used by building contractors and in construction camps, and in many other fields. They are particularly valuable in times of emergency when floods, windstorms or other causes have disrupted the usual light sources and rescue or repair crews are required to work at night or under unusual conditions.

During the period 1904-1906 the first automatic acetylene gas buoy was placed in use for the protection of ships while at sea or entering port. The construction of these buoys provided for a compartment to be charged with carbide which in turn was automatically fed into a chamber filled with sea water. The automatic acetylene lighthouse is still another gift of man to safeguard life and property on the seas, and large numbers of them are operated by means of carbide. A fog horn operated with acetylene gas; life belts equipped with a carbide light as an aid to show the location of persons in the water when forced to abandon ships, are still further contributions.

Of somewhat recent origin is a marine signal light used by seagoing craft when in distress. This is a cylindrical-shaped container attached to a lanyard. It is charged with carbide and when thrown overboard is ignited by means of the pull of the cord and the action of the water. It burns for a considerable length of time, depending on the size flare used and attracts attention of passing vessels.

Carbide Flare for "Bird Men"

Of importance to our "bird men" today is a variation of this device—a can-shaped light charged with carbide. When flying over bodies of water or along the coast lines, the flare is dropped into the water where it becomes ignited. The light is cast over a considerable surface permitting the aviator to spot locations and reveals dangerous rocks, etc. A distinct aid when a forced landing is necessary.

Harbors and parts of the coast lines of cities and ports all over the world are lighted and protected with acetylene gas lighting through the medium of various types of automatic devices. At dangerous curves on the highways, while driving at night, every one at one time or another has seen the "safety blinker" operated with acetylene.

For Folks Off the Beaten Path

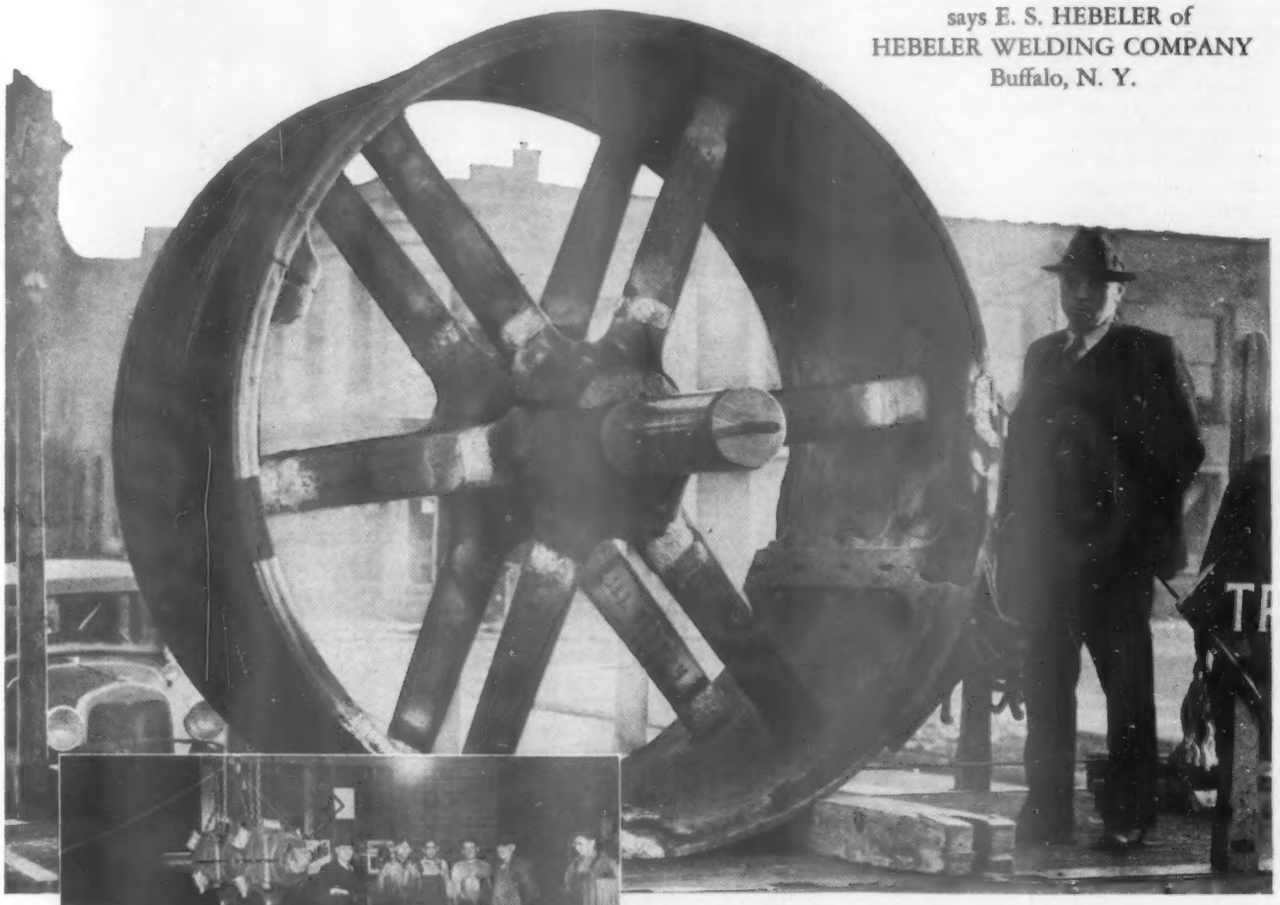
In relation to the home, it is easily understandable that in the more populated areas it is possible to locate manufacturing and distributing centers to supply both gas and electricity. But what of those isolated, less densely settled sections where gas cannot be piped nor power lines established, because of the practically prohibitive expense or because of physical conditions? The farmer, the rancher, and folks living off the beaten path are also entitled to and in need of the same light-conveniences as their neighbors in the villages and cities! Unto them too came the boon of acetylene gas from calcium carbide.

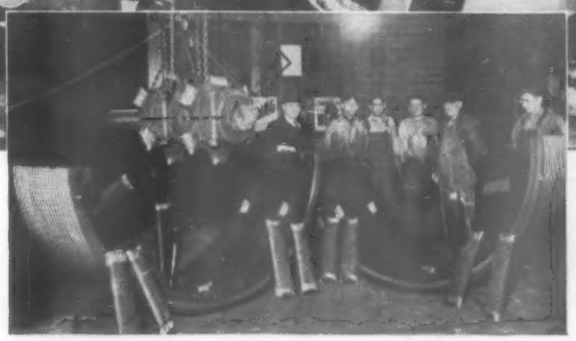
The production of acetylene gas from calcium carbide is probably the simplest and the most easily accomplished of all the manufacturing efforts for the obtaining of illuminating gases.

(To Be Concluded Next Month)

"We can't say enough good things about Tobin Bronze"

says E. S. HEBELER of
HEBELER WELDING COMPANY
Buffalo, N. Y.





"TOBIN BRONZE enabled us to do a spectacular job for the Bayless Pulp & Paper Company, of Austin, Pa.," Mr. Hebeler states. "The shaft in the 84" dia. 42" face, main drive *cast iron* pulley snapped between the two hubs, breaking all 12 spokes away from the hubs, and all but 3 away from the rim. The plant was paralyzed and it looked like a shut-down of four to six weeks for delivery of a new pulley. We were called in, and as no distortion of the rim could be allowed because it had 18 1¼" rope grooves, we decided brazing was the only suitable and quick method of repair.

"The pieces weighing 4½ tons were trucked to Buffalo, brazed with Tobin Bronze (which we use on *every cast iron job*, whether low-temperature is a factor or not) and returned to Austin in less than one week. *We can't say enough good things about Tobin Bronze.*"

When difficult welding jobs appear, nothing quite equals Tobin Bronze! This time-tried Anaconda product carries the trademark "Tobin Bronze Reg. U.S. Pat. Off." on each rod. Look for this mark and be sure you are getting genuine Tobin Bronze! 37284

ANACONDA
from mine to customer

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities . . . In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

News of the Industry

SINCE PUBLICATION of the September, 1937, issue of *The Welding Engineer*, the National Metal Exposition announced two additional exhibitors of particular interest to welding engineers. THE ELECTRIC ARC CUTTING & WELDING CO., Newark, N. J., occupied Booth C-5. A. O. SMITH CORP., Milwaukee, Wis., occupied Booth C-2. Full description of these exhibits was contained in the official convention program, copies of which were distributed at the exposition in Atlantic City.

HARD SURFACED VALVES were featured at the Chicago Power Show. A check up of exhibitors at the Chicago Exposition of Power and Mechanical Engineering (October 4-9) revealed that the leading valve and fitting manufacturers are now hard surfacing the vital parts of high temperature, high pressure valves and fittings to resist "wire drawing." Bronze valves were exhibited in a complete range of types and sizes; also iron and steel valves and lubricated plug-valves. One of the bronze valves exhibited used a seat and disc of high chrome, non-corrosive steel, heat treated to a minimum Brinell hardness of 500. Because of its extreme hardness, this valve can be closed on sand, slag or foreign substances without injury. Other valves of special interest to power men included a 150-lb. plug disc valve with alloy seats and discs. Of particular interest to many engineers was the fact that a number of the valves exhibited had beveled ends for welding directly into pipelines.

JOHN MCC. LATIMER has been appointed exclusive representative in the Western Pennsylvania territory by LUKENWELD, INC., designers and builders of welded steel structures, Coatesville, Pa. His headquarters will be in the Koppers Building, Pittsburgh.

Mr. Latimer was born in Washington, D. C., in 1896, and after graduation from Washington High School, attended Lehigh University from which he was graduated as a Civil Engineer in 1918. He enlisted in the United States Army Engineering Corps as a private, attended an officers training camp and received a second lieutenant's commission.

After discharge from the Army in December, 1918, Mr. Latimer joined the Eastern Car & Construction Co., Easton, Pa., being placed in charge of their Pittsburgh office in 1919. In 1925, he established his own business as a manufacturers' representative, handling the accounts of such firms as Eastern Car & Construction Co., Worthington Pump & Machinery Corp., and DeWalt Products Corp.

John McC. Latimer

Construction

THE PACIFIC IRON & STEEL CO., of Los Angeles, Calif., welded steel fabricator, recently completed an addition to its office building at 11,633 South Alameda Boul., Los Angeles.

THE DEEP OIL DEVELOPMENT CO., Wichita Falls, Texas, will build a $100,000 natural gasoline plant and other facilities in the near future in the Wichita Valley district. Welding will play an important part in this project.

Announcement was recently made by the RICHFIELD OIL CO. (Calif.) of plans for the early construction of a new $5,000,000 refinery at Watson, Calif. This program will require the installation of much high-pressure equipment as well as various auxiliary installations, practically all of which will be welded. Contracts for the work have not yet been awarded.

J. F. PRITCHARD & CO., Kansas City, Mo., are now constructing for the Petroleum Engineering Co., Dallas, Texas, a complete gasoline extraction plant near Haven, Kan. Natural gasoline will be extracted from the natural gas produced nearby.

TRUMAN-SMITH CONSTRUCTION CO., Eldorado, Kan., now have three pipeline jobs under construction. One project is 32 miles of 8 in. line near Waseca, Minn., for the Northern Natural Gas Co. The other jobs are take-up and relay work for Sinclair-Prairie near Henrietta, Mo., and Joliet, Ill.

Ryerson a dependable source for Welding Rod

• Ryerson Engineers have developed a series of rods that are outstanding for Quality production. More than twenty types, including both electric and gas rods, are carried in stock. Whether you need a shielded arc type for production work or a stainless steel rod you can be sure of immediate shipment... *Write for Bulletin which gives complete data.*

ELECTRODES

Ryerson
Shielded Arc Type
No. 215
Shielded Arc Type
No. 216
Shielded Arc Type
No. 217
Green Processed No. 18
Copper Coated No. 206
Copper Coated No. 210
Cast Iron

Ryerson
Green Processed No. 6
Bare Mild Steel
Brown Processed
White Flux Coated
High Carbon White Flux Coated
Blue Flux Coated

GAS RODS
3½% Nickel Steel
High Carbon Bare
No. 2110

Ryerson
3½% Nickel Steel Flux Coated
High Manganese Steel
Hard Surfacing
Allegheny Stainless Flux Coated
Allegheny Stainless No. 44

Tobin Bronze
Allegheny Stainless Bare
Hard Filler

JOSEPH T. RYERSON & SON, Inc., Chicago, Milwaukee, St. Louis, Detroit, Cleveland, Cincinnati, Buffalo, Boston, Philadelphia, Jersey City

A. W. S. Activities

SAN FRANCISCO SECTION—Preceded by the usual 6:30 dinner, the San Francisco Section of the American Welding Society held its first Fall meeting at the Athens Athletic Club, 12th & Clay Streets, in Oakland, on September 24. The main feature of the session was a sound motion picture on the production of stainless steel, furnished through the courtesy of the Republic Steel Corp., and presented by Frank Rider.

KANSAS CITY SECTION, American Welding Society, held its first meeting of the Fall season on September 27 at the Kansas City Power and Light Co. building, 14th and Baltimore Streets. FRANK C. HUTCHISON, manager of process service, of Linde Air Products Co., addressed the Section on the subject, "Fabrication of Structural Members and Machine Parts." His talk was illustrated with slides. An aggressive effort was made at this meeting to get new members to join the American Welding Society.

LOS ANGELES SECTION—The first Fall meeting of the Los Angeles Section of the American Welding Society was held on Wednesday evening, September 22, at the Central Manufacturing District Club, 4814 Loma Vista Ave. Following the usual 6:30 dinner, a paper entitled "Source of Materials, Manufacturing, Processing, Fabrication and Application of Stainless Steel," was presented by Frank Rider, of the Republic Steel Corp.

Trade News

R. D. MCMANIGAL has been appointed to the position of manager of the central station and transportation division of the Westinghouse Electric International Company. Mr. McManigal joined the Westinghouse Company in 1915, after graduation from Lafayette University with a degree in electrical engineering. Mr. McManigal will make his headquarters at 150 Broadway, New York.

THE LINDE AIR PRODUCTS COMPANY, unit of Union Carbide and Carbon Corp., has signed a contract for the occupancy of a new, fireproof office building at 729 North Pennsylvania St., Indianapolis, Ind. The new building, a two-story structure, is to be ready for occupancy on or about November 1, 1937, and will provide space for the Linde district office and a repair and service station for Oxweld oxy-acetylene welding and cutting apparatus. When it is completed, the Linde office, now located at The Prest-O-Lite Company, Inc., Speedway plant outside Indianapolis, will be transferred to the North Pennsylvania St. location in order to facilitate the handling of increased oxy-acetylene welding and cutting in the Indianapolis area. The new office will serve as a center of Linde operations covering an area the radius of which is roughly 125 miles, extending from Louisville on the South to South Bend on the North and from Columbus and Cincinnati westward to Illinois.

THE LINDE AIR PRODUCTS COMPANY, Unit of Union Carbide and Carbon Corp., announces that its Boston District Office has been moved to 441 Stuart St., Boston, Mass.

CLECO

B1 SCALING TOOL

The Slickest Tool You Ever Saw!

Try a CLECO B1 on your own work. You will agree there's no tool its equal for cleaning weld splatter; undercutting where overlapping is necessary; peining bead; taking off rust and old paint; removing sand from intricately cored castings such as motor blocks.

The harder you press a CLECO B1, the harder and faster it hits. The chisel can't loosen until you touch the thumb latch—it can't twist, no matter what you do, until you remove it.

Make us prove it in your plant—and let us mail you Bulletin 84.

THE CLEVELAND PNEUMATIC TOOL COMPANY

3734 EAST 78th STREET, CLEVELAND, OHIO, U. S. A. — Cable Address: PNEUMATIC

BRANCHES IN PRINCIPAL CITIES

Appointment of W. R. Persons as manager of its Pittsburgh welding sales and engineering office is announced by The Lincoln Electric Co., Cleveland, Ohio. Mr. Persons has been working in the Pittsburgh office since the Fall of 1934 and has a wide acquaintance with industrial firms in the district. His broad practical experience in arc welding and thorough knowledge of applications of the process to manufacture, construction and maintenance will be invaluable in his new position. In providing complete supply and consultation service to users and prospective users of welding in and around Pittsburgh, Mr. Persons will be assisted by J. H. Painter, M. S. Schonvizner, R. H. Schuster and H. E. White.

John Howe Hall has resigned as technical assistant to the president of Taylor-Wharton Iron & Steel Co., High Bridge, N. J., to engage in a consulting metallurgical practice. Mr. Hall will specialize in foundry work and in the manufacture and application of metals to resist abrasion and corrosion. Mr. Hall's change of business connection became effective October 1.

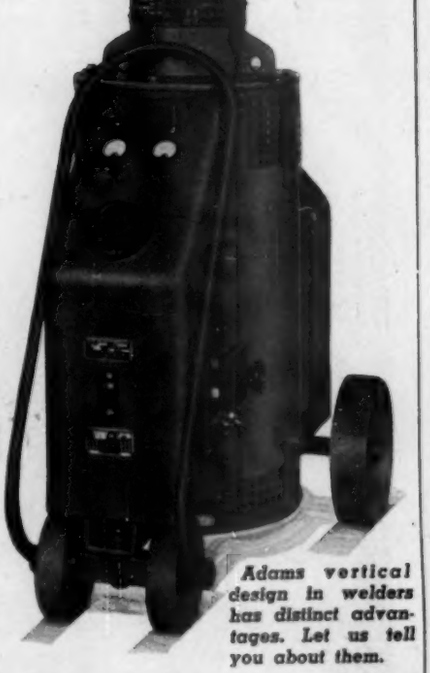
ADAMS Offers a Complete Line of Arc-Welding Equipment

WHETHER your need is for welding machines, electrodes or welding accessories, Adams can supply your needs from a line which offers many exclusive features. A request on your letterhead will bring complete descriptive catalogs on any of the following items:

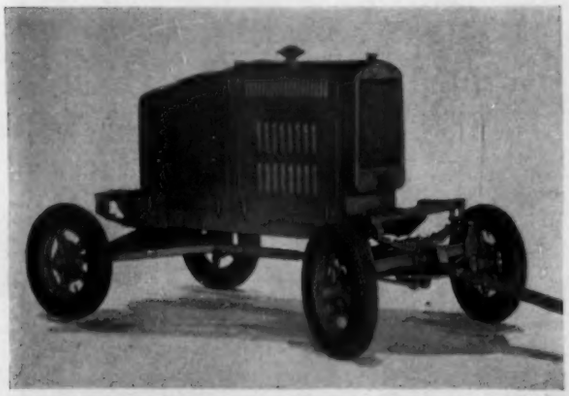
Adams Vertical Welders. Vertical design offers several advantages. DC machine available in 200, 300 and 400 ampere sizes; AC model in 300 and 500 ampere sizes.

Automatic Welding Heads and Wire. Outstanding equipment suitable for use in connection with any automatic welding set-up. Head has many desirable features.

Engine Driven Welders. Ideal for shop or field work. Available in 200 and 300 ampere models mounted on steel skids or trailer as illustrated below.



Adams vertical design in welders has distinct advantages. Let us tell you about them.



ELECTRODES

Adams offers all kinds of bare, processed and heavy-mineral-coated electrodes for the welding of mild steel, stainless steel, manganese steel and aluminum. . . . Tell us what you weld and let us send samples of the electrodes best suited to your work.

J. D. ADAMS COMPANY • INDIANAPOLIS, INDIANA

Welding Division

Acme Oxy-Acetylene Co., Inc., 3209 Madison Ave., Indianapolis, Ind., has just been incorporated. This company is fully equipped to supply every need of users of welding and cutting. This concern will act as distributor for the full line of Modern Engineering Co.'s welding equipment, Westinghouse arc welders, Page electrodes and gas welding rods, and Fuswell gas welding rods, together with compressed oxygen and acetylene. William P. Zimmerman is president and general manager of the new company. "Bill" Zimmerman has been selling welding and cutting equipment in Indiana for many years. For the past three years he conducted his own business under the name "Welders Equipment and Supply Co." This latter concern was consolidated with Acme Oxy-Acetylene Co. at the time of its recent incorporation. Other officers of the new company are: F. Waymire, vice-president and A. Albert Hinkle, secretary and treasurer.

Trade Literature

"The Characteristics of a Modern Arc Welder," is the title of a new folder describing how modern welder design meets all the requirements of present-day welding operations. Presenting a volt-ampere curve analysis for general welding, heavy welding and light-gauge welding, it goes into single-current control, self-excitation and other pertinent points in the design and construction of the Hansen Smootharc welding generators. Written by Frank J. Hirner of the welder division of Harnischfeger Corp., of Milwaukee, it helps clear up many points that may not have been thoroughly understood about welder design. Copies may be had by writing the Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis.

New Hard-Facing Procedure Booklet—The Linde Air Products Company, unit of Union Carbide and Carbon Corp., announces the publication of a folder, entitled "Steel Hard-Facing Procedure." This useful pamphlet has been reprinted from the April, 1937, issue of "Oxy-Acetylene Tips," and presents detailed instructions for applying the hard-facing material, Haynes Stellite, to steel wearing surfaces. Illustrations, sketches, and a new, simplified step-by-step procedure should enable any welding operator to hard-face steel with good results.

The procedure, as described, begins with the preparation of the steel part and discusses each operation in turn, including preheating, hard-facing, cooling, and finish grinding. All necessary precautions and recommendations are given for each step. In addition, general recommendations for the proper grade of alloy for hard-facing many machine parts are presented, together with a discussion of blowpipe tips, sizes, and methods for drawing out hard-facing welding rod. Copies are available without charge or obligation from any office of The Linde Air Products Company.

THE CHAMPION RIVET COMPANY, Cleveland, Ohio, has issued a new catalog describing its complete line of welding electrodes. In its 56 pages are included: welding procedures for pressure vessels, and low alloy steels, physical and metallurgical facts on the art and application of the shielded arc process together with a handy reference section of useful tables and data.

"NEW PROFITS IN ARC WELDING With The New Simplified 40-Volt Hobart Arc Welder" is the subject of an interesting booklet just issued by Hobart Brothers, Troy, Ohio. It is packed full of money making suggestions for job welding, blacksmith, auto repair and machine shops. From a study of the table of contents, it is apparent that the new book contains a wealth of information for the job and repair shop owner. Typical of the subjects covered are: "Where an Arc Welding Job Shop Will Pay"; "Special Training for General Job Welding"; "Essential Equipment for the Job Shop"; "Extra Profits from Portable Equipment," and "How to Build a Job Welding Business."

JACKSON ELECTRODE HOLDER CO., 6553 Woodward Ave., Detroit, Mich., has issued a small folder describing its complete line of insulated electrode holders. Illustrations in color are included and also essential technical information as to current carrying capacity and sizes of welding rods accommodated. Costs of replacement parts for Jackson holders are also shown in this folder.

"ARC WELDING FOUNDATION NEWS," October, 1937, has just come off the press. This first edition, issued by The James F. Lincoln Arc Welding Foundation, Cleveland, O., announces in newspaper style the latest details regarding the $200,000 award contest. The Foundation was created late in 1936 for the express purpose of stimulating scientific progress of the arc welding industry. The $200,000 award program is the first important activity of the Foundation in carrying out its plan to develop the progress of arc welding.

MIDGET MARVEL FLEXARC WELDER is described in a folder recently issued by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Construction, specification and operating costs are included together with questions and answers covering use of this unit.

HAYNES STELLITE CO., Kokomo, Ind., now has available two folders designed to aid the small welding shop owner in increasing his hard-facing business. Both folders can be used as envelope stuffers. "Plow The Economical Way with Haynes Stellited Plowshares," an 8-page booklet, is illustrated with a number of photographs of typical farm implements hard-faced with Haynes Stellite. Results of comparative service tests of hard-faced implements and steel implements are given to show the longer life obtained after hard-facing. "Protect Wearing Parts—Cut Cost With Haynes Stellite," is of a more general nature and illustrated with typical hard-facing applications in a number of industries, including the agricultural, excavating power, brick and cement, and lumber and paper industries.

The word OKONITE or MANSON on a roll of tape means that under all manner of conditions, in every kind of weather and service, these tapes stand the siege of time. Day in and day out, year in and year out, these tapes last. They last, in fact, just as long as the insulation on the wire itself.

The lifetime of a splice made with OKONITE and MANSON Tape is, therefore, equal to the lifetime of the wire. Durability, permanence—factors of true economy in the maintenance of your lines—are thus assured when you specify:

OKONITE TAPE—a rubber insulating tape, made of highest grade rubber and compounding ingredients that form a homogeneous mass of high dielectric strength and impervious to moisture.

MANSON TAPE—a rubber filled cloth tape for the mechanical protection of joints. Made by true friction method, this protective tape is unequalled in its adhesive qualities and length of service.

Write for samples and our booklet, "Splices and Tapes"

THE OKONITE COMPANY
Founded 1878
and
HAZARD INSULATED WIRE WORKS DIVISION

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Belong to the Regulars!

Avoid delay

Write today

Share the wealth on Welding

Send your application for membership in the American Welding Society before November 10th in order to be listed in the 1937 Yearbook—the "Who's Who in Welding."

Information:
American Welding Society
33 West 39th St., New York City
or
The Welding Engineer
608 So. Dearborn St., Chicago, Ill.

THE WELDING EVENT OF THE YEAR!

COME TO THE 18TH ANNUAL MEETING, AMERICAN WELDING SOCIETY, ATLANTIC CITY, OCTOBER 18-22